ELEVENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1918-1919

SUPPLEMENT TO THE REPORT OF
THE DEPARTMENT OF AGRICULTURE

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ELEVENTH ANNUAL REPORT

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1918 - 1919

To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir:—

I have the honour to present herewith the Eleventh Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 2nd of April, 1919.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

J. M. SWAINE,

Secretary-Treasurer.

Ottawa, 1919.

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Vanderleck, J ..... Macdonald College
Victorin, Rev. Bro ..... Longueuil, Que.
Willey, Prof. A ..... 58 Metcalfe St., Montreal
Winn, A. F ..... 32 Springfield Ave., Westmount

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Hon. J. E. Caron, M.P.P., Quebec.
Hon. Jules Allard, M.P.P., Quebec.
F. C. Harrison, D.Sc., Macdonald College.
Canon V. A. Huard, D.Sc., Quebec.
Rev. Father Superior, La Trappe.
Rev. Father Superior, Ste. Anne de la Pocatiere.
Auguste Dupuis, Village des Aulnaies.

FINANCIAL STATEMENT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES, 1918-1919

Receipts

Brought forward	$249.67
Provincial Government Cheque	100.00
Interest on Deposit	7.78
	$357.45

Disbursements

Expenses of Members and Lecturers to Annual Meeting	$ 36.55
Expenses of Delegates to Ontario Entomological Society	64.60
Tablet to Provancher	30.00
Delegate to Royal Society Meeting	12.00
Express and Postage	11.55
Secretary	50.00
	$214.85
Balance in Bank, April 2nd, 1919	$142.60
	$357.45

Auditor:

E. MELVILLE DUPORTE,

J. M. SWAINE, Secretary-Treasurer

WM. LOCHHEAD, President.

ELEVENTH ANNUAL REPORT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

Report of the Summer Meeting

A special meeting of the Society was held on August 7, 1918, at the Parliament Buildings in Quebec in commemoration of the scientific services of the late Abbé Leon Provancher, the eminent Canadian Naturalist. One of the chief objects of the meeting was to unveil a brass tablet erected in the Provincial Museum in honor of Provancher by the Quebec Society for the Protection of Plants.

The unveiling ceremony was conducted by Professor Lochhead before a large audience in the Exhibit Chamber of the Provincial Museum. The tablet in honor of the famous Abbé bears the following inscription (in French).

In Memory
of
LEON PROVANCHER
Entomologist and Naturalist
1820–1892
Erected by the Quebec Society
for the Protection of Plants
1918

The members and delegates later adjourned to the Public Bills Committee room where the general meeting was held. In a fine address President Lochhead paid a warm tribute to Provancher's scientific attainments and remarkable industry through which he was enabled to contribute so largely to our literature. Mr. George Maheux, Provincial Entomologist, reviewed the life and career of Provancher, and Dr. C. Gordon Hewitt, Dominion Entomologist, discussed his scientific investigations and paid a warm tribute to the technical value of his publications. The Provincial Government was represented by Hon. Cyrille Delage, and the Minister of Agriculture by Mr. J. A. Grenier, who delivered very appropriate addresses. They were followed by Lieut.-Col. H. O. Roy, who with his wife, son and daughters represented the family of the late Abbe Provancher. In his address Lieut.-Col. Roy expressed his appreciation of the honor paid to his wife's uncle by the Society. Madame Roy had lived with her uncle, the Abbé

Provancher, and helped him with his work; it was therefore most fortunate that the Society was able to have Lieut.-Col. Roy and his family present at the meetings.

The Quebec Meeting in commemoration of Provancher will be remembered as one of the most successful ever held by the Society.

Among those present at the meeting were: Professor William Lochhead, of Macdonald College, President of the Society; Rev. Father Leopold of Oka, Agricultural Institute, Vice-President; Dr. C. Gordon Hewitt, Dominion Entomologist; Dr. J. C. Chapais; Dr. Charron, Director of the Provincial Chemical Laboratory, St. Hyacinthe; Professor Geo. Bouchard, Agricultural School, St. Anne de la Pocatiere; Doctor J. M. Swaine, Entomological Branch, Ottawa; Hon. Cyrille Delage, Superintendent of Provincial Education; Mr. J. A. Grenier Deputy Minister of Provincial Department of Agriculture; Mr. George Maheux, Provincial Entomologist, Mr. F. N. Savoie, Secretary of the Provincial Department of Agriculture; Lieut-Col. H. O. Roy, Madame Roy, niece of the late Abbé Provancher, and her two daughters, Misses Alice and Germaine Roy and her son, Mr. Joseph Octave Roy, and many others.

Report of the Winter Meeting

The eleventh annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College, on Wednesday, April 2nd, 1919.

Business Meeting

The Business Meeting was opened by President Lochhead at 2.00 p.m. Among those present were: Professor W. Lochhead, Dr. Rankin, Dr. Chapais, G. Maheux, Professor G. Bouchard, C. E. Petch, C. B. Hutchings, C. Gooderham, L. S. McLaine, Dr. J. M. Swaine, Father Leopold, Father Fontanel, Father Magi, Dr. J. A. Corcoran, G. C. Piché, H. F. Kieffer, J. H. Menard, Professor Letourneau, Mr. R. Brodie, P. I. Bryce, E. M. DuPorte, Dr. Hamilton, A. F. Winn and E. Ness.

The minutes of the last meeting as given in the 10th Annual Report were approved.

The report of the Treasurer was read and accepted.

The following officers were elected for the ensuing year:—

President—Professor W. Lochhead, Macdonald College.
Vice-President—Rev. Father Leopold, La Trappe.

Secretary-Treasurer—Dr. J.M. Swaine, Chief of Division of Forest Insects, Ottawa.

Curator and Librarian—P.I. Bryce, Assistant in Biology, Macdonald College.

Directors—Rev. Dr. Thomas Fyles, Ottawa; Prof. Letourneau, La Trappe; Rev. Bro. Victorin, Longueuil; A. F. Winn, Montreal; Rev. Prof. Fontanel, Montreal; G. Maheux, Provincial Entomologist, Quebec; G. Chagnon, Montreal; Prof. G. Bouchard, Ste. Anne de la Pocatiere.

Auditor—E. M. DuPorte.

Delegate to Royal Society of Canada—Professor W. Lochhead.

Delegates to the Ontario Entomological Society—Father Leopold or Professor Letourneau; Professor Bouchard or H. Roy.

The two usual grants of fifty dollars from the funds of the Society for expenses in connection with special investigations of insect and fungous diseases in the province were continued for another year.

It was reported that the publication of Part IV of the List of Insects of the Province of Quebec had been delayed, but would be proceeded with this summer.

The Secretary reported the erection of the Society's tablet in memory of Provancher at a cost of thirty dollars.

The place and date of the Summer Meeting of the Society were left to the decision of the executive.

GENERAL SESSION

The general session of the Eleventh Annual Meeting was opened at 3.15 p.m., in the Biology Building by the President, Professor Lochhead.

In the absence of Dr. Harrison, Professor Lochhead welcomed the visiting delegates to Macdonald College and extended to them its hospitality.

The President's address and all the papers presented are printed in detail in the body of the Report. Several of the papers were well illustrated by lantern slides, maps and photographs. The evening lecture was given by Dr. W. H. Rankin, of Cornell University. Dr. Rankin dealt with "Efficiency Factors in Potato Spraying" in a very timely and instructive address. One of the most interesting features was an account of community spraying for potatoes as practised in parts of the State of New York.

PRESIDENT'S ADDRESS:

METHODS OF STUDYING ECONOMIC INSECTS

Prof. W. Lochhead, Macdonald College

Criticism is sometimes made of the character of the undergraduate instruction in Economic Entomology on the ground that students on graduation are unable to conduct investigations in the "field-stations" without considerable suggestion and supervision. To my mind this criticism is somewhat unfair. The same criticism might readily be made against graduates in Engineering, Medicine and Law. The undergraduate has been busy learning the fundamentals, and has not had time to make much direct application of his knowledge. Those students who are fortunate enough to get employment during the summer vacation in field or station work acquire a certain amount of valuable training in the conduct of investigations under supervision, but it should be understood that the power to conduct independent research is developed mainly in the period after graduation and after considerable experience.

It should be borne in mind also that the majority of the field-stations have special problems to solve, involving frequently specific methods of investigation. It is manifestly unfair, therefore, to expect a raw graduate to jump in and carry on the work like an experienced worker.

When one reviews the literature of Economic Entomology one is somewhat astonished to find so few articles devoted to methods of investigation and study. Occasionally one comes across a bulletin where the methods and devices used in the experiments are described, but such bulletins are only too rare.

The most complete American guide to collecting, killing, preserving, pinning, mounting, and rearing insects is Dr. C. V. Riley's bulletin, entitled "Directions for Collecting and Preserving Insects" published by the Smithsonian Institution, Washington, in 1892. Professor Comstock's "Insect Life," published in 1897, also contains much valuable information relating to these same matters, and both works should be freely consulted by the entomologist. Most of the information given in these treatises is still up-to-date and requires but few amendments. During the last twenty years, however, the study of economic insects has been carried on more intensively as well as extensively, and the requirements of the investigators have stimulated the production of many rearing devices which are not described in the publications mentioned above.

This paper is an effort to gather together in one article the details of of devices used by some of our best economic entomologists in their investigations, with the hope that young workers, even older ones, may find them suggestive and helpful.

Fig. 1.—The Riley Insect Cage, Fig. 2.—The Webster Cage. Fig. 3.—A Lantern Globe Cage (*Photo by W. A. Ross*). Fig. 4—A Lamp Chimney Cage. Figs. 5, 6. —A Cage adapted by Comstock for the study of wireworms. Fig. 7.—Section of a Root Cage (*After Comstock*). Fig. 8.—Flower-pot Cages for the study of white grubs (*Photo by J. J. Davis*). Fig. 9.—Cylinder Cages (*Photo by J. J. Davis*).

Conditions of successful rearing of Insects.—In general, success in rearing insects demands experience in selecting those conditions of existence that will permit the insect to make a normal development. It is very easy to place an insect in abnormal conditions, consequently the investigator must have a fair knowledge of its habits in all stages in its normal environment before he attempts to rear it under a more or less artificial environment.

The important factors in successful rearing are stated by A.M. Wilcox (*Psyche*, Feb. 1917) as follows:—

1. An abundance of normal food.
2. A suitable environment for the different stages.
3. The regulation of temperature and humidity.
4. The prevention of disease.
5. The prevention of parasitism.

The most experienced rearers are often disappointed at times, but the results can usually be traced to neglect in taking proper precautions at some stage. Failure occurs most often with regard to the regulation of temperature and humidity, for these factors also play an important part in attacks of disease. Eggs, larvae, and pupae are influenced detrimentally either by too little or too much moisture, besides moulds are very apt to develop under conditions of excessive humidity.

The general rule is to make conditions as near the natural as possible, but of course we all know how conditions in nature may sometimes be abnormal, if we may judge by the large percentage of deaths that occur some seasons. A better rule would be to make the conditions natural without the introduction of the lethal factors that sometimes operate in nature.

Simple Cages —All kinds of devices for rearing insects and observing their work—from simple and easily constructed types, to elaborate insectaries—have been in operation for many years. The simpler types range from shell vials, tin salve-boxes, tumblers, lamp-chimney-flower-pots to cages of various forms, depending on the kinds of insects under investigation. Several workers find shell vials very convenient in rearing many forms of insects, even large caterpillars. One larva is placed in a vial along with a piece of its food plant which is renewed every day, and the vial plugged with cotton wool. When large numbers are being handled, the vials may be arranged in flat trays even three tiers deep, so that they can be examined readily and at the same time occupy a small space (Figs. 1 and 2).

The lamp-chimney or lantern-globe cage has long been in use by students of Entomology (Figs. 3 and 4). It may be placed over a plant growing either in soil in a flower pot or in a large vial of water and upon which insects are feeding. Cuttings of plants can be kept fresh for a long time when placed in a small vessel of

water. The top of the globe or chimney is covered with cheesecloth muslin tied on securely. Professors Comstock and Slingerland used a modified form of this type of cage in their studies of wireworms (Figs. 5 and 6). A glass cylinder took the place of the lantern chimney, but it was cemented in place with plaster of paris to prevent the wireworms from escaping. The flower pot was plugged at the bottom and placed inside a larger one, the intervening space being filled with sphagnum which was kept wet. Sufficient water "passed through the porous sides of the pot to keep the soil in good condition" (Bull. 33, Cornell. 1891).

In recent studies of white-grubs in Indiana, Mr. J. J. Davis has devised some new forms of root-cages for field work, which he buried in the soil (Figs. 8 and 9). Flower-pot cages of various sizes (12, 15, 16 inches in diameter and depth) as well as cylinder-shaped cans of 18-inch galvanized wire cloth with wire covers. Mr. Davis says he found the flower-pot cages the most satisfactory, being "easily handled, cheap and well suited for underground insects." He also used as a check cage a large rectangular cage 8 ft. long, 5 ft. wide, and 5 ft. high, buried for $2\frac{1}{2}$ ft. in the soil (Fig. 10). This cage is constructed of metal and wooden frames and covered with 18 mesh pearl wire cloth. It was found useful also in studying the seasonal life history of the army worm.

Care must be taken, however, to water the soil in the cages and to make conditions like those in ordinary soil. "During the winter the covers are removed and the pots covered with straw and this with strawy manure to a depth of one foot, which will gradually pack down to a comparatively thin layer."

For getting eggs and records of individual pairs of white-grubs Davis fills 12-inch three-quarter or standard size pots with finely sifted soil. If the soil is kept properly watered the ball-like masses of earth containing the eggs can be obtained by sifting and placed in shallow tin egg-cages in cavities in the soil (Fig. 11).

Davis found one-ounce tin salve-boxes most satisfactory for studying the habits, growth, and moults of the larvae (Figs. 12, 13). The boxes are filled with soil and moistened to the proper degree and a grain or two of wheat or corn added. The boxes may be placed in tin trays in a cabinet and thus easily examined. In preparing the boxes for over-wintering all grain and vegetation are removed, the soil, carefully watered, and the tin trays are buried in a compost heap to a depth of from one to two feet.

More Elaborate Cages and Insectaries—Professor Comstock of Cornell was one of the first to build an insectary for the study of insects. It contained as essential features a conservatory divided into a hot house and a cold house, a cold room for hibernating insects in the basement, a workshop, a photographic room, a store-room and an office. This building was used for about twenty-five

Fig. 10.—Large Cage used for the study of army worms and white grubs. (*Photo by J. J. Davis*) Fig. 11.—Flower pots used to get eggs and records of individual pairs of white grubs. (*Photo by J. J. Davis*) Fig. 12.—Tin salve boxes in a tray used for studying the habits of growth of white grubs. (*Photo by J. J. Davis*). Fig. 13.—A White grub in a Salve box. (*Photo by J. J. Davis*). Fig. 14.—Tin tray used in white grub investigation. (*Photo by J. J. Davis*). Fig. 15.—A battery jar aquarium for aquatic larvae. Fig. 16.—A Root cage (*After Comstock*). Fig. 17.—A Root Cage (*After Comstock*). Fig. 18.—A large Cage used to study the cabbage root maggot (*after Slingerland*). Fig. 19.—A handy insect cage, three sides and top covered with copper wire screen and the door of glass. (*Photo by Dr. Matheson*).

Fig. 20.—A large insect cage used for the study of apple maggot in the Orchard. (*Photo by W. H. Brittain*). Fig. 21.—A large box-like cage used for breeding Apanteles out of brown-tail Caterpillars. (*Photo by G. E. Sanders*). Fig. 22.—A parasite breeding tray. (*Photo by J. D. Tothill*). Fig. 23.—A Fiske tray. (*Photo by J. D. Tothill*) Fig. 24.—A tachinid rearing box. (*Photo by J. D. Tothill*). Fig. 25.—A parasite rearing box. Fig. 26.—Interior view of Insectary, Fredericton, N.B., showing arrangement of Fiske trays in racks. (*Photo by J. D. Tothill*)

years and served as a model for others that were erected later at the Experiment Stations. (See Bull. 3, Cornell Ag. Ex. Sta. 1888).

At the time Professor Comstock was making a special study of wireworms, and in this connection he contrived an ingenious root-cage where the larvae could be observed while feeding upon the roots of the plants growing in the soil of the cage. (Figs. 16 and 17.)

He also contrived a special cage divided for a short depth into 60 compartments to determine the effect of salt in driving wireworms deeper into the soil.

Professor Slingerland described in Cornell Bulletin 78, 1894, a large cage designed especially for the study of the Cabbage-root Maggot. This was essentially a framework screwed together and covered with tarlatan, and was 7 ft. long, 3 ft. wide, $3\frac{1}{2}$ ft. high at the front, and 2 ft. at the back (Fig. 18). This form of cage has been used extensively (Fig. 20) in field and insectary investigations (See Brittain, Bul. 9, N. S. Dept. Ag.).

Rearing Parasites—On account of the important part played in the control of injurious insects by parasites considerable attention has for some years been given to the study of these small forms. The greatest advance, however, in the methods of rearing has been made in connection with the campaign in Massachussetts against the Gypsy and Brown-tail moths. The introduction of parasites of these moths from Europe and Japan, concerning which much was unknown, necessitated first a careful study of their habits and later the elaboration of methods of rearing them on a large scale for distribution in the affected zones. As a result, several new devices and cages have come into use. Fiske has described several of these in Bul. 91, U. S. Bur. Ent. One of these is a rearing cage for tachinid parasites of the cocoons of the brown-tail, which was specially devised to meet peculiar conditions. A simpler form (Fig. 25) was used for rearing the parasites from the hibernating webs.

Mr. G. E. Sanders of Anapolis Royal, N.S., contrived a box for breeding *Apanteles* out of brown-tail caterpillars (Fig. 21). A large box-like cage was made for the reception of three or four thousand brown-tail webs. There the larvae were fed for about a month, or until the webs of the *Apanteles* are observed among the food. The brown-tail larvae are then killed with poisoned food and the cage left open to allow the *Apanteles* to emerge and fly away. This method of preserving the parasites had essentially been previously adopted by Riley in Missouri for the rascal leaf-crumpler and the bagworm, by DeCaux in France for the apple *Anthonomus* weevil, by Comstock for the imported cabbage worm and the Cotton Caterpillar, by Berlese in Italy for the Grapevine *Cochylis*, and by Silvestri in Italy for the olive fly and other pests.

Through the courtesy of Mr. J.D. Tothill, of the Dominion Entomological

Laboratory at Fredericton, illustrations of some of the appliances used for the rearing of the parasites of the brown-tail moth are here reproduced.

The **Fiske Tray** in which the caterpillars are fed has shallow wooden sides and a cloth bottom (Fig. 23). Around the inside of the tray about $1\frac{1}{2}$ inches from the cloth bottom is placed a strip of tanglefoot to keep the caterpillars from crawling out. Fig. 26 shows the arrangement of the Fiske trays in racks in the insectary.

The Parasite Breeding Tray (Fig. 22) is a modified Fiske tray, 9 inches square and 1 $\frac{3}{4}$ inches deep. It has a cloth bottom, a removable glass top and a hole in the front plugged with a cork. In one corner of the tray is a handful of soil kept moist by a piece of blotting paper dipping into a dish of water outside. Small granules of sugar and flour can be placed in the tray as food.

A Tachinid Rearing Box is a wooden box 5 inches square and 7 inches deep with a wire mosquito netting on the bottom and a glass on the top. After it is half filled with moist soil the puparia are placed within. In the front is a hole for the reception of a glass vial or a cork. A telescoping wooden cover fits over the top of the box excluding the light and forcing the flies to emerge into the vials (Fig. 24).

A. M. Wilcox gave in Psyche, Feb. 1917, a valuable account of some devices he has used in rearing insects through all the stages. He finds small tin covered fruit jars, 4 inches in diameter and 4 inches deep, very convenient and giving successful results when certain precautions are taken for the regulation of the humidity, air and food supply, and disease. Besides lepidopterous forms he has bred wood-boring insects in fruit jars, but a little more care must be taken to prevent mould.

Mr. Wilcox has also used successfully small tin boxes with tightly fitting covers (Fig. 27). In rearing fruit flies he uses test tubes plugged with cotton. Into each tube he put some banana agar, and allowed the tube to cool, in a slanting position (Fig. 28).

Insectaries may be simple or elaborate according to the requirements of the situation. Field laboratories are usually simple structures containing the essential equipment only. One room may serve as office, laboratory, and place where simple rearing experiments are conducted (Fig. 29, 30, 33). If more accommodation is required a skeleton shelter with canvas, wire netting, or muslin screening, is constructed where the rearing can be carried on under more natural conditions.

Figures 31 and 32 show the nature of the shelters used by J. J. Davis of Lafayette, Ind., and W. A. Ross of Vineland, Ont., for the investigation of plant lice. When trees are convenient the shelters may be placed under them and the screens removed.

Fig. 27.—Pomatum boxes used in breeding. (*After Wilcox*). Fig. 28.—Plugged test tubes used in rearing fruit flies. (*After Wilcox*) Fig. 29.—Entomological laboratory and insectary at Fredericton, N.B. Fig. 30.—Entomological laboratory at .Treesbank, Man. Fig 31.—Shelters used for plant lice investigations at Vineland, (*Photo by W. A. Ross*). Fig. 32.—Shelters used at Lafayette, Ind. (*Photo by J. J. Davis*). Fig. 33.—An outdoor laboratory with tar-paper roof and screened with wire netting. (*Photo by Dr. Matheson*).

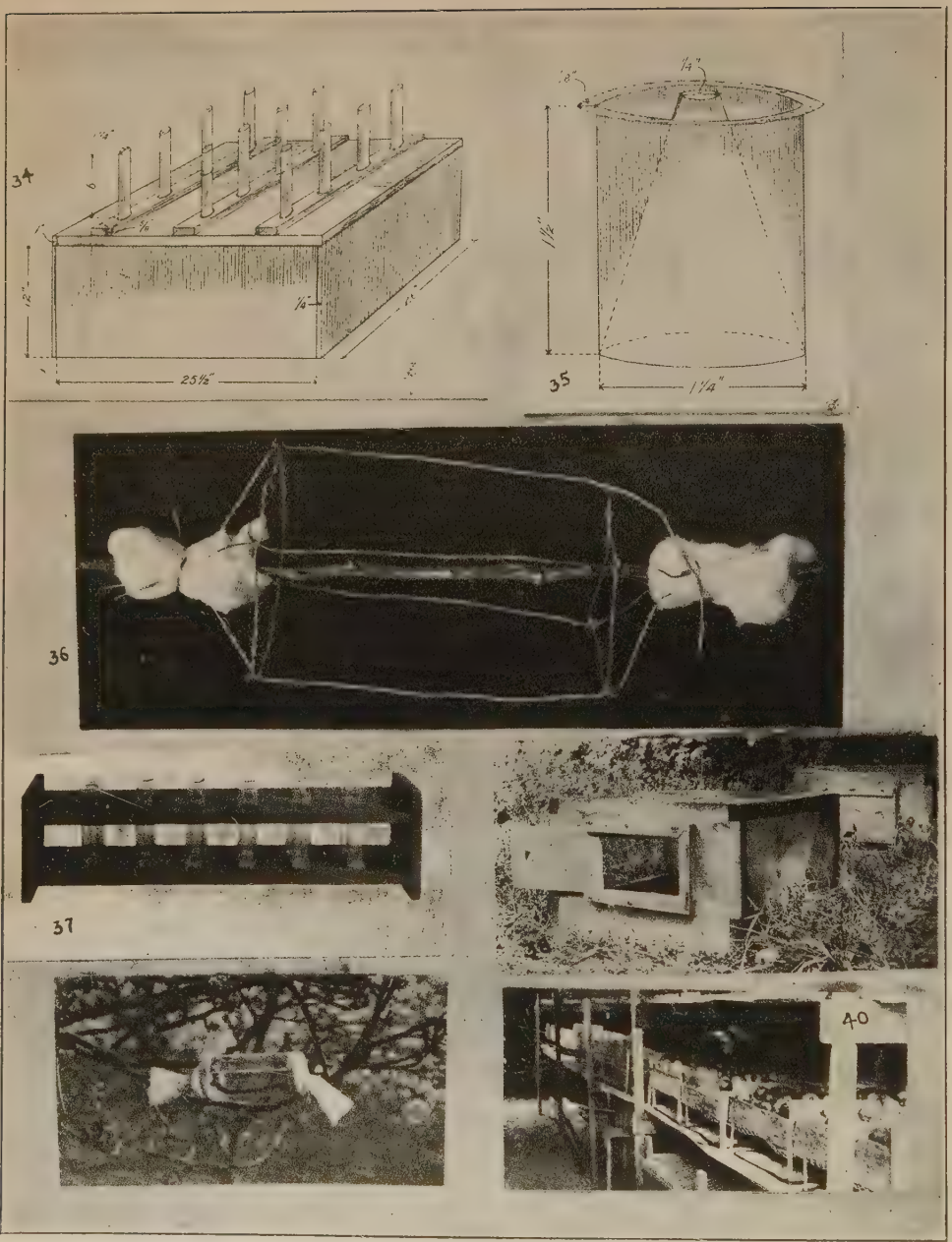


Fig. 34.—Trap emergence box used for determining the first appearance of pear thrips in the spring, and their numbers in the soil. (*After Cameron and Treherne, B.C.*) Fig. 35.—Combined trap cone and cylinder of tin used for holding the glass vials and filled into the holes of the soi emergence boxes. (*After Cameron and Treherne, B.C.*) Fig. 36.—The skeleton wire twig cage to be covered with cheesecloth. (*After Parrott and Fulton*) Fig. 37.—A convenient method of storing insect material. (*Photo by Parrott and Fulton*). Fig. 38.—A convenient box-like cage. (*Photo by W. A. Ross*) Fig. 39.—Boxes used in experiments relating to pupae of Apple maggot fly. (*After W. H. Brittain*). Fig. 40.—Boxes used in experiments relating to the larvae of Apple maggot fly. (*After W. H. Brittain*).

The more elaborate insectaries have greenhouses attached and have accommodation for the office, containing the collections and library, the photographic room, a cold storage room, for hibernating forms, and sometimes a room for sleeping quarters.

Twig Cages—In the study of insects that attack buds it is often necessary to place cages on the twigs so as to enclose the bud and the insect. Parrott and Fulton of the Geneva Station, in their studies of tree crickets as disease carriers, devised a skeleton wire cage of copper wire (Fig. 36). Two copper wires of unequal length were twisted tightly for a short length near their middle, then spread and bent into the form required. The end of the long wire was wrapt around the twig with cotton to hold the cage in place which is then covered with a cheese cloth. This cage is also useful in the study of aphids.

Cameron and Treherne of Vernon, B.C., used mica chimney cages in their study of the oviposition of pear-thrips on the buds. These cages were filled with a cotton sleeve at each end and securely fastened to branches of the trees.

The same investigators devised trap-emergence boxes for determining the first appearance of pear-thrips in the spring and their numbers in the soil. Figures 34 and 35 furnish the details of the construction of such a box.

The list of rearing devices described in the foregoing pages is very incomplete, for nearly every investigator of insect life history has contrived some device that he has found useful. Unfortunately, however, many have not taken the trouble to photograph and describe it. The writer is under deep obligation to those entomologists who have sent him photographs and descriptions for the purposes of this article. He is hopeful, however, that a more complete article will soon be prepared by some person who will take the trouble to illustrate and describe all the rearing devices in use by our entomologists, for he believes that such an article or bulletin would be a helpful reference guide in the majority of stations and laboratories.

REPORT OF THE DELEGATE TO THE ONTARIO ENTOMOLOGICAL SOCIETY

Professor Firmin Letourneau, La Trappe, P.Q.

On the 4th and 5th of December, Father Leopold and I attended the 55th annual meeting of the Entomological Society of Ontario as delegates of the Quebec Society for the Protection of Plants.

The President of the Society, Professor Caesar, had obtained for the convention the accommodation of the Ontario Agricultural College, where we were greeted and entertained with a kindness which we shall always remember.

Prominent entomologists of Eastern Canada and several from the United States were present at the meetings.

Early in the session, it was Father Leopold's privilege to open a discussion on spraying in the orchards, which brought out the following points:

It seems that in Nova Scotia, on account of the peculiar climate, Lime Sulphur occasions a considerable drop of apples, while in Quebec and Ontario this does not occur, and Lime Sulphur, it seems, is still going to be used extensively as in the past. Professor Parrot of Geneva affirms that dropping does not occur in New York either.

Bordeaux mixture, since it causes russeting of fruit, should not be applied after the petals of the apples have dropped, but may be safely applied before, for the first semi-dormant spray or for any spray before the calyx spray.

Dusting so far has been successful, whenever applied with care, but it would not be safe to recommend its use to replace the liquid spray until more is known about this relatively new application.

After this discussion, Messrs. W. A. Ross and L. Caesar, gave us an excellent paper on the principal insects of last season in Ontario: Cherry Flies, the Pear Psylla, the Raspberry Miner and the Strawberry curculio, etc.

Dr. A. C. Baker, of the Washington Bureau of Entomology sent a paper on Aphids, He find that they have a certain economic value, in the lact that the Nut galls, of which China has made an industry, are their product. But they certainly are the authors of much damage by attacking plant tissues and acting as carriers of disease.

Dr. Slater-Jackson of the Department of Zoology, McGill University, gave

the members quite a number of new ways of keeping the larvae and caterpillars of many insects with their natural colors. Here is one of the formulas:

Cane sugar.....10 parts
Acetic acid..... 5 parts
Formaldehyde..... 2 parts
Distilled water to make 100 parts.

Plunge the specimens in some of the liquid and after 24 hours, throw this away and change to another bottle of the same liquid. Repeat this a third time at an interval of 24 hours. Cork well after the third time.

We were favored with an excellent paper by Mr. N. Criddle. His paper was on the subject of "Some insect problems in the Prairie Provinces."

Mr. J. D. Tothill, Dominion Entomological Laboratory, stationed at Fredericton, N.B., gave us an interesting talk on the results of the Recovery of the Brown-tail Parasite, *Compsilura*, in New Brunswick. This valuable parasite, imported through the Entomological Branch at Ottawa, is now part of our Canadian fauna. This is a very encouraging fact that crowns with success a very worthy cause.

At the Evening Session, Dr. Creelman addressed the assembly and was followed by Mr. J. A. Morris of Peterborough, who, as usual, delighted his audience with a very excellent paper on "The Life-History of a Hobby-Horse." The popular lecture, this year, was given by Mr. John J. Davis, of the United States Bureau of Entomology, West Lafayette, Indiana, who closed the day by speaking on "Present Day Problems in Entomology." Mr. Davis would like to see more effective co-operation between all agriculturists, especially in the wide field of Entomology and Pathology, and the farmers. Experience, he stated, has taught us that the promiscuous mailing of Bulletins is a waste.

On the following day, the President of the Society, Mr. L. Caesar, opened the meeting by an address on "Insects as disease carriers." Dr. S. Hadwen, of Ottawa, showed us interesting slides on Oestrids and Bot flies, contributing more knowledge on that practical subject. Mr. Arthur Gibson spoke on the Cabbage Maggot, Mr. F. W. Sladen on Bees, Professor Lochhead, our own President, on "Some Early Chapters in Entomology." Dr. Walker, of Toronto, on "The Genitalia of Primitive Insects." Mr. Ross gave us more details on the Pear Psylla and Professor Caesar a synopsis of the means of getting rid of the Apple Maggot.

We came back much pleased with a most interesting meeting.

THE SPARROW QUESTION

Rev. P. Fontanel, S. J., St. Mary's College, Montreal

My hearers will excuse me, I hope, for imposing on them an article on such an apparently insignificant subject. But as the object of our Society is to help the farmer, and as I am of the opinion that something can and should be done in this line to assist him, I beg to submit for your consideration the following reflections.

Naturally there are two points to be considered: first, "The evil effects" and second, "Means of control."

1. Evil Effects

Many are of the opinion that the evil done by the sparrow has been greatly exaggerated. This opinion prevails especially among city people. These certainly are to be pardoned for their limited view of the extent of harm and inconvenience these birds cause. On the other hand, I cannot admit all the accusations that have been brought up against them. Charge after charge has been brought forward without sufficient proof, and real or probable services rendered to the community have not been considered. For example; the destruction of insect eggs in early spring, fall and winter, and the hordes of insects eaten in late summer and autumn by large flocks of sparrows, have been practically overlooked.

Furthermore, a ten years' experience has proved to me that even the dissection of a stomach may lead, and easily does lead, to error; and I fear that some biologists have not always seen this difficulty. Therefore, I shall be convinced only by experiments of the first order, by statistics taking into account all circumstances that may change the nature of the case: the time, day and place of capture. The diet, etc., are facts that must be taken into consideration. Investigations so far made leave serious doubts in my mind, consequently I feel justified in saying that the evil effects of the sparrow have not as yet been made sufficiently clear. For the present I shall not enter into a discussion of this point. However, for the benefit of those who have not studied the question for themselves, I shall quote the opinion of two naturalists, without further comment The first is that of Dr. C. Gordon Hewitt, taken from the Agricultural Gazette of Canada, September, 1915: "The house sparrow, is a pest of the first order and should be treated as such." This is the conclusion drawn from an investigation of the harm sparrows have done in gardens and fields in and around cities and of their violent persecution of more useful birds.

The second opinion is that of Ned Dearborn in "The English Sparrow as a Pest," revised edition, 1917, U. S. Department of Agriculture. It reads: "The evidence against the English sparrow is, on the whole, overwhelming" p. 4.

Under these authorities I shall seek protection against accusations of cruelty, and I contend that my stand may be justified from whatever point of view the evil effects may be considered. The fact itself that sparrows are omnivorous and eat seeds readily, tend at once to awaken our suspicions. Now if they are allowed to multiply indefinitely we shall soon discover that the harm they work will increase at least in proportion to their numbers. This fact can more easily be admitted if we consider that the number or insects on which they might otherwise feed are relatively scarce. Of this I am in a position to give positive proof.

A large number of sparrows killed during the month of August had eaten in a single day a minimum of twenty grains of oats or wheat each. Now during the harvest season they gather in large flocks and in search for food they settle down on grain fields breaking and destroying much more than they eat. People who have observed them readily admit that the two grains are wasted to the one eaten. Thus we have a minimum of sixty grains of wheat or oats per sparrow per day: which amounts to two gramme or 1–15 of an ounce. Accordingly ten thousand sparrows would account for about one ton of grain in one season. Now, ten thousand sparrows is but a small fraction of Montreal's army alone. Consequently, even if it can be proved that sparrows are more useful than injurious under normal conditions, yet under present circumstances we are fully justified in at least lessening their numbers. To my mind the time has come for serious action. For whilst complaints become more numerous and serious every day and the naughty sparrow is allowed to multiply enormously out of proportion to his usefulness, no step has as yet been taken to reduce the number or check the evil effects.

But what should be done to eliminate the sparrow evil.

II. Means of control

I have studied this question for many years. The detailed account of my researches is actually published in the "Naturaliste Canadien". In this article several practical methods of destruction have been suggested: shooting, capturing by hand, destruction of nests, co-operation of children, trapping and poisoning. It is to this latter method only that I wish to draw your particular attention to-day, referring my hearers to the "Naturaliste Canadien" for further particulars.

No doubt the indiscriminate use of poison would lead to many serious objections. The danger to man and beast, the natural aversion many people have for poison in any shape or form, besides the utter uselessness and in some cases

the positive harm that may result from poisoned bodies of birds, are facts that must be considered. But there are still other difficulties to be met with in the use of poison. The sparrow manifests almost a human aversion or distrust for any sort of preparation. The taste, color and smell awaken his suspicion or distrust. After many attempts with the various methods prescribed in different works I succeeded in poisoning scarcely fifty sparrows in ten years; although I have tried most poisons, both ordinary and extraordinary. I think I have at last found one that will fulfil all the required conditions: harmless to other animals, easily prepared, taken readily, and so tested that I can recommend it with all confidence. This poison is "*Nitrate of Strychnine*". In spite of its bitterness, poisoned grains are eaten as readily as those that are not so treated. Wheat grains are preferred to any other kind. The grain is soaked for ten hours in water containing one per cent of the Nitrate. The liquid not absorbed is drained off and used without delay for another quantity of wheat, otherwise fermentation would set in and destroy the poison. The soaked grain is allowed to dry and is then ready for use.

Usually the best time for operations is in the evening before sunset when large flocks gather together on open ground near their roosting place to play and eat before retiring. The grain is previously scattered about so as not to excite their suspicion. The marvelous effects of this method are quickly perceived. An occasional bird dies on the ground, but it happens so quietly and peacefully that he does not disturb his companions. The greater part, however, find their way to the trees whence they drop quietly to the ground dead. Paralysis of the vocal chords prevents the usual startling cry which frequently terrorizes the yet unaffected ones when other strychnine compounds are used. This latter fact is of the greatest consequence.

The time required to kill ranges from three to twenty-five minutes; but the greater number die between five and fifteen minutes. An exceedingly small quantity of poison is required for effective work, as is shown by the following figures:

Dry wheat was used in the experiments. Thirty grains weighed one gram, and one ounce of nitrate gave a solution sufficient to poison 180,000 grains, that is, one grain contained one six thousandth (1–6000) of a gram. of the poison.

Experiments performed in the Laboratory on captured live sparrows showed that three grains would kill one bird, while those poisoned in the open were found to contain but three or four seeds. It is certain, of course, that only a small portion of the poison eaten does the work, whence it follows that the fatal quantity is less than one two-thousandth (1–2000) of a gram, while physicians usually administer doses ranging from one-thousandth (1–1000) to three-thousandths (3–1000) of a gram, or one-sixtieth (1–60) to one-twentieth (1–20) of a grain.

These figures show clearly the little danger that exists for other animals. As a matter of fact I have seen a good sized dog eat, in five minutes, six poisoned sparrows without the least bad effect. I have also seen cats devour from three to four within half an hour and no serious consequences followed. Both figures and facts go to show that no fears should be entertained on this question.

But what about chickens and other birds? Evidently the danger is real. As to chickens, the solution is very simple; do not place or scatter the seed where they can reach it. For other birds the difficulty is not so easily solved. However, let us not forget that but very few of the species living near our dwellings eat wheat: the native sparrow is the only one I know around Montreal. To protect these we can take advantage of their early migration south. Apart from this we can use other precautions. For example, scatter the grain only a few minutes before the sparrows come down in flocks from the trees, and after they have finished, bury or sweep up the remainder. It is well to note that even native sparrows eat but little wheat. In a garden where I scattered poisoned wheat indiscriminately and without precaution, I picked up bodies of only three native sparrows, while at the same time 4,000 house sparrows were poisoned.

Now the next question is the cost of these operations. The figures quoted above to show the harmlessness of the poison afford us an easy means of calculating the expense. Buying nitrate at the rate of $2.50 an ounce we can poison sparrows at a rate of 240 for one cent, according to laboratory experiments. For practical purposes, however, we shall be content with 1–10, or 24 sparrows for one cent. These figures will square pretty well with these successive lists made during the past season. In the first, 600 birds were killed at the rate of 24 for one cent; in the second 1900 at the rate of 40 for one cent and in the third 900 at rate of 20 for one cent. In these figures no account is taken of birds dropping outside the grounds on which the experiments were carried out.

Now a word about the experiments. After many smaller experiments both in the laboratory and in the open I decided to test the poison on a larger scale. This was carried on in a garden during the month of August, 1918. The grain was scattered in select places and the sparrows were closely watched for upwards of an hour each day. The result was that 4,000 bodies picked up in the garden itself were buried during the month (from August 7th to September 7th). Now I think I am safe in saying that one third as many more died outside the garden, and of course were not taken into consideration.

From this I conclude that the efficiency of the method cannot be questioned, and it is my humble opinion that with perseverance and co-operation the sparrow nuisance can be effectively controlled.

In conclusion, if the authorities should consider seriously the sparrow question and encourage destruction, I would suggest the following:

1. To prohibit the sale of Nitrate of Strychnine to individuals.

2. That the wheat should be prepared by a responsible firm and sold to responsible persons.

3. To forbid the use of this poison on land other than one's own.

If these suggestions were strictly followed, the danger for man would be entirely removed, and the temptation avoided of putting poison everywhere, of putting it in other food, and in greater quantity than necessary.

THE PEPPER AND SALT MOTH, AMPHIDASIS COGNATARIA GN.

J. C. Chapais, St-Denis-en-bas, Que.

I wish to present to you to day a few notes on an insect which is one of the best examples of protective mimicry amongst insects, *Amphidasis cognataria*, better known in English under the name of Pepper and Salt Currant Moth. I will first give its classification. **Phylum,** Arthropoda; **Class,** Insecta; **Order,** Lepidoptera, **Family,** Geometridae; **Genus,** Amphidasis; **Species,** cognataria Gn.

The larva is known under various names such as: Measuring-worm; Span-worm; Loop-worm; Geometer and Looper. The insect is known in French under the scientific name of *Lycie vulgaire*, and the common name of *Arpenteuse cendree.* Here is the description given of the species by Slingerland and Crosby.

"Currants and gooseberries are sometimes defoliated by a geometrid cater-"pillar or measuring-worm which, when full-grown, is nearly two inches in length; "it varies in color from sea-green to brownish-grey or brownish-black and is "marked with indistinct lines and spots of green and yellow. When at rest, "it clasps a twig with the posterior pairs of legs and holds the body extended "rigidly outward; it is then easily mistaken for a dead twig, which it closely "resembles in form and color. It is a general feeder and rarely becomes a pest "on currants. This species occurs in the Eastern states and Canada."

"The caterpillars become full grown in early July and transform to a dark "brown pupa in the ground. At least, part of the pupae give rise to moths the "same season, about the middle of August, but it is quite probable that some of "this brood hold over till the following Spring. The rather heavy-bodied moths "have an expanse of about two inches; the wings are gray dotted with dark brown "and crossed by two wavy bands of mahogany brown on the outer third. Moths "of the spring brood appear in May. The eggs are about 1/30 inch in length, "cylindrical with rounded ends, and the surface is beautifully marked with rows "of hexagonal depressions. A single moth has been known to lay about 500 "eggs."

"Arsenical poison as used against the imported currant worm will hold this "insect in check."

I said above that this caterpillar is one of the best examples of protective mimicry ever met with. It has two pairs of prolegs with which it clasps a small twig and holds it rigidly for a long time without moving. It is so much like the twig that often one takes it for a dead and dry twig. I remember that, about

twenty years ago, I found the first caterpillar of this species I ever saw on a plum tree. It had a sleek and glossy skin soft as velvet, and I was almost horror-struck when I happened to feel what I thought a dead twig moving and wriggling under my fingers. Slingerland and Crosby say in their description that this insect is a general feeder, In fact, I have found it feeding on plum trees, currant bushes and, last summer, I found a whole colony of it on sweet clover, *Melilotus alba*. They were there, about 15 or 20 of them, feeding quietly, and I could observe them at leisure during about eight days, finding after that lapse a few, two or three, brown cocoons of the caterpillars, which I gathered and kept to see their metamorphosis. This took place at the end of last January and I have here one empty cocoon and the dead moth, then living, as I found it on January the 25th. It is very curious to find such a small and short cocoon, about three-fourths of an inch in length, being the final habitation of such a long caterpillar, almost 2 inches in length.

DUSTING AND SPRAYING SUGGESTIONS FOR QUEBEC

C. E. Petch, Entomological Laboratory, Hemmingford, Que.

Our knowledge of chemicals used as fungicides and insecticides is increasing each year and evolution in this work is proceeding satisfactorily. Each year a new formula of an old remedy is found or chemicals new to the work are discovered. For example, London purple gave place to Paris green, which latter has been largely replaced by lead arsenate, and now evidence is at hand of it being largely discarded for calcium arsenate.

Lead arsenate is used in the powder and paste forms, and while there may exist certain conditions in which the latter is preferable, I think the advantage of the powder form should cause it to replace the paste in all but these exceptional cases. When the powder form is used there is at least equal killing power, more constant analysis, less freight to pay, no time lost by mixing, easier manipulation, and it can be kept from one season to another without loss.

There has been and there still is considerable difference of opinion as to whether calcium arsenate is a safe insecticide to use with lime sulphur. I am not in a position to say definitely, but I have used it for two seasons at a rate of ¾ lb. to 40 gallons diluted lime sulphur without any apparent injury. I have used it without injury at a strength of ten per cent in a dust mixture of equal parts of sulphur and talc. When used with Bordeaux mixture on potatoes I have found it to be vastly superior to Paris green or lead arsenate. Its most serious drawback is that it cannot be used alone. This coming season it is to be compared with lead arsenate when both are added to lime-sulphur solution. It is proposed to carry this experiment over a 5-year period.

An eminent authority on spraying stated a year or so ago that lime sulphur lessened the apple crop as much as 50% or more. Since that statement was made a great many, who had used lime sulphur successfully for years, have become converts to Bordeaux mixture. Under extreme conditions Bordeaux mixture is superior, but for conditions such as exist in this province, I believe careful applications of lime sulphur will give equally good results. Regarding the large reduction in the crop there has been no substantial evidence to support that statement so far as the province of Quebec is concerned.

Hydrated lime is being used extensively now in spraying and the time is not far distant when it will almost entirely replace the stone or quick lime. It is cheaper and saves considerable time in the manufacture of Bordeaux mixture, but my experience has been that this mixture does not adhere so well as when quick lime is used. There are two grades of hydrated lime, one rich in calcium

carbonate and the other high in silica. The former is the cheaper and better grade for spraying purposes, therefore, remember to purchase "high grade calcium hydrated lime."

I have often been asked, "which is better, dusting or spraying?" In answer to that question I would say that during the past two years dusting has given results equal to spraying and both methods produced perfect fruit and foliage. There is another very important consideration other than the control of insects and diseases and that is cost. My experience has been that dusting is almost doubly expensive. Nevertheless, if a grower has an orchard requiring over two days to spray it once, I would recommend him to dust. It is easy to dust four times as much as can be sprayed in the same length of time, especially when working on large trees. While I am satisfied with dusting so far, my experience is as yet so limited that I do not care to recommend this method too freely. However, everything points towards reducing the cost and with more experience better mixtures will be known and dusting will then take its proper place.

In the Annual Report of the Pomological and Fruit-growing Society of Quebec 1917, page 62, there is *considerable written* about spray guns and spraying the underside of leaves. I have found it impossible to obtain similar results.

"When to spray," which also implies *to acquire* the best results, is certainly a difficult question to answer with only our present information at hand. For a long time our growers followed the Ontario spray calendar and wasted considerable money on dormant sprays. Next they followed the Nova Scotia calendar, and I presume if somebody in Australia would send up a programme it would secure a large following. It is safe to presume there will never be a universal spray calendar, and one suitable to all conditions in this country is almost as improbable. Logically, then, the thing to do is to study local conditions and develop the most suitable spraying system. It is necessary to do this because insects and diseases vary with the season and with the locality.

THE PRESENT SITUATION OF THE BROWN-TAIL MOTH IN EASTERN CANADA

Leonard S. McLaine, M.Sc., Chief, Division of Plant Inspection, Entomological Branch, Department of Agriculture, Ottawa

In reviewing the brown-tail moth situation in eastern Canada it is necessary to discuss the problem in the various infested provinces separately, as the existing conditions in the provinces to be considered are entirely different and the control work itself has to be planned and modified in order to meet the requirements of each individual case.

Although the province of Quebec has never actually been invaded by the brown-tail moth, so far as we know, it has been necessary to scout and inspect certain portions of the eastern townships on account of their proximity to the infested areas in the states of Vermont, New Hampshire and Maine. For the past few years the brown-tail moth has been gradually working northwards until now it is within twenty miles of the Province of Quebec. The portion of the province which is in greatest danger of being infested by this pest lies between Lake Memphremagog on the west and the international boundary on the east. On account of this danger the territory mentioned has been thoroughly scouted at various intervals, so that control measures could be brought into play before the insect had an opportunity of making any great headway. There is little doubt, however, that the insect would spread rapidly should it succeed in passing the southern boundary of the province on account of, at least two conditions which are favourable for its increase and dispersion. There are many food plants in this area and they are well scattered. Among the food plants may be cited both the cultivated and wild apple, wild cherries, thorns and amelanchiers. Furthermore, the topography of the country is of such a nature that when once the border is crossed, the brown tail would spread rapidly and with ease, as the boundary country is a watershed area with the Green mountains, drained by the Connecticut river to the south, and to the north, drained by the St. Lawrence, are gentle undulating plains, mostly open, with occasional hills. An open country such as this, with many favoured host plants is ideal for the spread of this pest.

The condition of the brown-tail moth in New Brunswick can hardly be characterized as serious at the present time, as no nests of this pest were discovered this past season (1918-19). This is the first time that New Brunswick has been free from this insect since 1910. The fact that no nests were found during the winter 1918-19 does not signify, unfortunately, that the province will remain uninfested from now on, as the infestation is more or less epidemic in character.

This is readily illustrated by an examination of the number of nests that were found from year to year.

Nests Collected in N.B.

1911-12	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19
2,452	81	28,100	239	395	375	62	0

The variation in the number of nests collected from season to season is largely due to the geographic position of the province in that it borders the state of Maine and is in close proximity to the heavy infestations in the neighboring New England states. If the meteorological conditions are favourable at the time of the brown-tail flight in the latter areas, New Brunswick is reinfested. These flights, fortunately, occur very irregularly. The heaviest invasion of moths occurred in the summer of 1913. As a result of that flight eleven of the fifteen counties of the province were infested and the total area of infestation covered practically two thirds of the province. The following winter over twenty-eight thousand winter webs were collected and it looked as if the brown-tail moth would obtain a firm foothold. By employing a sufficient number of conscientious scouts a serious situation was relieved. To this must be added, however, the extreme severity of the winter which caused an unusually high mortality among the caterpillars in the "missed" winter webs.

From then on, the work progressed very favourably, the outside territory was gradually cleared up and in 1917-18 only three localities were found to be giving any definite amount of trouble. In all three districts the brown-tail was breeding and in addition two of them were reinfested each year. Considerable difficulty was encountered in clearing up districts where the snowfall was unusually heavy and the winter nests were covered with snow. Experiments carried on at the Fredericton Laboratory proved that the mortality rate among larvae in nests covered with snow was extremely low, and that these nests which could not be found by the scouts were responsible for maintaining an infestation which otherwise could be cleaned up.

The work in the province of New Brunswick has developed into a policing and patrol system, and the number of scouts employed is reduced to a minimum. If we do not get an overwhelming flight from the United States, no great difficulty is anticipated in keeping the brown-tail moth well in hand in that province.

The situation in Nova Scotia is very different from that of New Brunswick, as the brown-tails were well established and breeding extensively before the Dominion Government took over the control work. Furthermore, the climate throughout the Annapolis Valley, where the worst infestation occurs, is milder, and more favourable food plants both wild and cultivated are very much more common. In fact the entire infested area in this province is ideal for this pest on account of

PLATE VI

1. SNOWBANK. DEEP SNOW FREQUENTLY COVERS WINTER WEBS
2. WORKING IN AN ORCHARD
3. OFFICER EQUIPPED FOR WINTER WORK.
4. TYPE OF INFESTED COUNTRY, VICTORIA CO. N.B.

the abundance of food plants of various species which extend throughout the Valley. Owing to the different conditions it is necessary to modify the work in the two provinces. In New Brunswick the infested area is only examined once, whereas, in Nova Scotia it is often necessary to examine certain localities, where the nests are plentiful, two or three times in order to clean them up.

For a number of years the infestation was confined to the western end of the Annapolis Valley, and it was hoped that it would be confined to this area by the artificial barrier of Kings county to the east. This county has a large acreage in orchard, most of these being well taken care of and thoroughly sprayed. Unfortunately the pest passed this barrier and has extended as far east as Windsor. As soon as this fact was established a counter attack was planned, and the present policy is similar to that adopted by the United States Government in their gipsy moth and brown-tail moth control work; that is, confining the pest to its present area by laying particular stress on the outside territory of the infestation and gradually working towards the centre.

Local infestations have caused a good deal of trouble in handling the control work in Nova Scotia and in several instances radical measures have been necessary. In 1915-16 two thousand nests were collected on a hillside at Torbrook. The vegetation consisted largely of thorn and it was soon seen that hand picking of the nests would not be effective. The entire area was sprayed with oil and burned over. Excellent control resulted from this treatment and the area has been comparatively free ever since. The same year a small island in the Sissiboo river at Weymouth Falls was found to be heavily infested. The vegetation consisted of scrub thorn, rose, etc. and many of the nests were found close to the ground. The island was accorded the same treatment as that at Torbrook, with the result that the entire area was entirely freed of the brown-tail moth, no nests being found during the past two years.

Although there has been a gradual reduction in the number of nests collected in Nova Scotia during the past few years, as is shown by the following table, we realize that the brown-tail is breeding extensively; furthermore the most conscientious inspector may miss nests, and in a mild winter the mortality rate among the hibernating larvae will be low. Consequently it is necessary to continue a vigourous campaign to keep this pest within bounds.

Nests Collected in Nova Scotia

1909-10	1910-11	1911-12	1912-13	1913-14
1,496	4,462	8,070	11,005	24,156
1914-15	1915-16	1916-17	1917-18	1918-19
18,254	14,845	10,019	3,024	1,269

In addition to the artificial control work against the brown-tail moth, natural control forces have been brought to play against this pest by the introduction and colonization of three different species of parasites. These were all reared at the Gipsy Moth Parasite Laboratory, Melrose Highlands, Masssachusetts, through the courtesy of Dr. L. O. Howard and Dr. A. F. Burgess of the United States Bureau of Entomology. The parasite work was continued for four successive summers and during that time over 100,000 specimens were imported into Canada.

The Braconid, *Apanteles lacteicolor* Vier, has been recovered in New Brunswick and Nova Scotia. The brown-tail webs collected during the winter are saved until spring, and the parasites reared from the larvae as soon as the latter leave their nests.

The Tachinid, *Compsilura concinnata* Meig., has been liberated in Quebec, New Brunswick and Nova Scotia. This parasite was recovered at Fredericton in 1918, two years after the last colony was liberated. Eighty-six thousand, seven hundred and forty-two native hosts were collected to obtain this recovery, which was made from *Hemerocampa leucostigma*. The other hosts used were *Euvanessa antiopa*, *Datana ministra* and *Pontia rapae*.

The predaceous beetle *Calosoma sycophanta* has also been liberated in Quebec, New Brunswick and Nova Scotia. This insect can withstand our rigorous climate as several specimens were kept at the Fredericton Laboratory for a number of years. Specimens have been recovered in the field twice, but not within the past two years. This coming summer a field scout will be made in several localities.

SOME PROBLEMS IN BOTANY AND ENTOMOLOGY

Canon V. A. Huard, Quebec

It very often happens, in the study of science in general, and that of Natural History in particular, that we find ourselves confronted with a fact which completely upsets our ideas. When we have first convinced ourselves of the reality of the fact, a necessary step, we endeavour to discover an explanation, and one is not always forthcoming. The majority of naturalists have had at one time or another an experience of this kind. For my part I have been not a little astonished to find *Aesculus hippocastanum L.* the Indian Chestnut or "horse chestnut." This tree, of Asiastic origin, belongs to the flora of Southern America. Again in the case of the Hazel, *Corylus avellana*, a tree belonging to South Europe, I found a specimen in a vigorous state of growth at Neuville (Portneuf), that is to say, as in the case of the Chestnut, on the North bank of Saint Lawrence. It is, however, in the domain of entomology that I have had the most unexpected surprises in this direction. *Erebus odora L.* is a large butterfly whose wings spread more than 6 inches, and are greyish brown in colour, marked with black and white wavy lines and spots. This is a tropical species which has been seen occasionally at Montreal and at Metis. Despite this fact, however, the Rev. Dr. Fyles, who has collected in the environs of Quebec for forty years, has never taken it, and it is not represented in his rich collection.

Nevertheless, I took one specimen of it near the Basilica of Quebec in the month of July, 1909. Why was that single specimen found there, how did it find its way there? To these questions we know of no reply. But here is something no less extraordinary. On the 6th of May 1881, and that date shows at least that I have long since lost the right of styling myself a young entomologist, my collection was enriched by a specimen of *Stretchia plusiiformis* Hy. Edw., taken in the seminary building itself at Chicoutimi. This is a night flying butterfly, of medium size, with blackish front wings, and hind wings of a paler hue. But, the astonishing part of this occurrence is that *Stretchia plusiiformis* is a species belonging to California, Colorado, Nevada and Oregon, in other words Western America. And here we capture an individual specimen in the heart of Eastern America. How could such a thing come about? Who shall say? Here then, is a mysterious fact of which we must be content to have no explanation. But in any case, it is an extraordinary fact, that the only specimen of *Stretchia plusiiformis* ever seen in the East, should have been taken at Saguenay, so far from from that part of America where this species is indigenous.

But even the above is nothing compared with the entomological surprises I experienced several years ago, when someone brought me a beautiful specimen of

Hoplia caerulea, which had been found, dead it is true, in a street of one of the suburbs of Quebec.

This insect is a pretty beetle, rather small in size, thickset, almost cubical, of a clear velvety green colour presenting a most beautiful effect. This is a species of S. Europe, and it has been found in a Quebec street.

Never was I more puzzled than by the discovery, on a bouquet of artificial flowers upon an altar, of an authentic specimen of *Hoplia caerulea*.

In that case I had the solution of the problem. These artificial bouquets are often imported from Lyons, France, and the local artists, to give those flowers which they are making more resemblance to the natural flowers, place upon them one of those beautiful insects, which add still more to their beauty.

We know, also, that in the tropics, ladies' dresses are sometimes ornamented with some specimen, living or dried, of those beautiful golden green insects which are found in these regions of wonderful natural products. Again we know that the ladies of these regions go so far as to carry, as a precious ornament, little lizards of the genus *Anolis*, which possess the peculiar power of being able to change in an instant from their beautiful light green colour to a more or less dark red colour.

The case of *Hoplica caerulea* has nothing mysterious about it, once the facts are known. But there is no similarity in the occurrence of *Stretchia plusiiformis* at Saguenay, which remains in the condition of an insoluble problem.

This fact, however, and others which could be brought forward, do not prevent the fact being true in a general way, that the animal and vegetable species are always specialised for any large terrestrial area. Only man, and those animals and plants which he has so to speak domesticated has installed himself and prospered in all climates. And it is still necessary for him, to prevent them from returning to a savage state, or being destroyed by natural enemies, to keep a constant watch over them.

It is to fill this role of guardian more effectually, that there have been founded in different countries, and notably in our Province, Societies for the Protection of Animals and Plants, whose members can prove their fidelity by rendering important services to their country.

THE IMPORTED ALDER LEAF MINER

C. B. Hutchings, Entomological Branch, Ottawa

The fine group of alders at the Experimental Farm, Ottawa, has for many years been attacked by the alder leaf miner, *Kaliosysphinga dohrnii* Tischbein.

The most casual observer visiting this section of the Arboretum during the summer months could not fail to notice on the leaves the brown blisters which give the trees the appearance of having been badly scorched.

This injury is due to a small black saw-fly which appears in early summer and lays its eggs on the leaves. In about a week the eggs hatch and the leaves begin to show signs of the tiny larvae starting their operations. At first, each miner works independently; but it very often happens that many eggs are laid on the same leaf, and the workers meeting with tunnels of other workers, their mines coalesce and in this way the whole upper surface of the leaf is lifted. The larvae attain full growth in three weeks. They drop to the earth then, where transformation is carried on within small earthen cocoons just below the surface of the ground. There are at least two broods at Ottawa, and in favourable seasons possibly three, but since the broods overlap it is often difficult to state accurately where one stops and another begins.

From the few publications available on this subject, it appears that the fly was imported into Canada from Europe, between 30 and 40 years ago, but there is no record of the exact date when this actually occurred. Dr. Fletcher in a report in 1891, published in Can. Ent. Vol. 23, p. 252, very briefly referred to it as damaging alders at the Farm. Two years later, 1893, Mr. Harrington of Ottawa noted in Can. Ent., Vol. 25, p. 59, the insect working on native alders near the Farm. That same year Mr. Dyar of N.Y., reported in Can. Ent., Vol. 25, that this insect was seriously affecting the American alders at Wood's Hall, Mass. At Ithaca, N.Y., the fly appeared in 1891, and Mr. Slingerland made a study of it, publishing his results in Cornell Bull. 233.

Adult: The adult is a small, black saw-fly, 3 mm. long, with very shiny head and body, and wings somewhat smoky. It is very closely related to the Elm Saw-fly and except for a slight difference in the wing venation the two species are very much alike.

Flights occur in the latter part of May or early in June, and again in the middle of July.

In 1916, as my investigations did not start until July, I consequently missed the first flight, but I witnessed the second which was on July 20. In 1917 the first

brood appeared on June 6, and the second on July 20. In 1918 the first brood appeared on May 21, and the second on July 13. One or two stray flies were observed in late September at work ovipositing. These I took to be a third generation.

The flies on emerging immediately begin to oviposit, choosing the soft, tender, young leaves in which to insert their eggs, in preference to older and harder foliage. During the warm sunny days there is much activity and the flies are not readily taken, but on cloudy days the insects are dull and easily caught in wide-mouth bottles. I have watched carefully for males but have never observed any sign of mating.

Egg.—The egg, which is white, round and .3 mm. in diameter, is inserted into the leaf through the upper surface in a slit made by the saw of the fly. Many eggs may be laid on the same leaf by the same fly. These hatch in about 8 days.

Larva.—The young larvae work at first in very restricted areas, but later due to the joining up with other mines the entire parenchyma of the leaf is eaten out and the upper surface becomes brown and badly blistered. When fully grown they average 7 mm. long and .75 mm. wide, are of a shiny white at the extremities, noticeably segmented, the alimentary canal showing green through the skin. The thoracic legs are brown, ringed and situated somewhat laterally, the prolegs being rudimentary.

Pupa.—When ready to pupate the larva eats a hole in the ceiling of its prison and drops to the earth where it constructs a small, very dark, oval cocoon about 1 inch below the surface of the soil. As the silk is very sticky, sand and small readily adhere to the pupal cases, giving them odd irregular shapes. The pupal transformation requires about three weeks to complete.

Control.—First as to natural control, I found during the summer of 1917 a species of mite attacking the fly, and from some pupal cases I had caged in the insectary several hymenopterous parasites emerged.

I have also observed numbers of the flies caught in spider webs in the alders. From observations made in experiments, it is apparent that many adults, from various causes, become imprisoned in their cocoons and never get to the surface of the ground.

Under artificial measures several contact insecticides have been tried. Kerosene Emulsion, 1 part stock to 5 parts water, was found the best spray. This was applied when the larvae were young and their work beginning to be noticed on the leaf surfaces, and killed practically 100 per cent of the larvae. A weaker solution, 1 part stock to 7 parts water, was effective only when applied immediately after the eggs had hatched.

The Imported Alder Leaf-mine: -Figs. 1 and 2, blotch-mines of the larvae; 3, an adult fly; 4, an affected leaf showing the larvae in their mines; 5, puyal caser; 6, larvae removed from the mines.

Immunity.—At the Arboretum we have about 25 different varieties of alder, the majority of which are subjected to various degrees of attack. There are a few, however, which I have found during the three seasons work to be immune. They are:—

Alnus serrulata
Alnus incana
Alnus carpinua betula
Alnus oblongata
Alnus macrophylla

This immunity, in all probability, may be due to the thick and hard texture of the leaves of these varieties, as the flies are never found on them, although these trees are closely situated to those that are very severely attacked.

A CANADIAN BEE COLLETES INAEQUALIS SAY

Rev. L. M. Stöhr, College St. Alexandre, Ironside, P. Q.

The aim and object of your society, as its name implies, being the protection of plants against insect and fungous diseases, its field of action would seem to be confined to the discovery, eradication and prevention of those ravages for which insects and fungi are responsible. Nevertheless, would it not be restricting your field too much to exclude from discussion every question which did not seem to have a directly practical bearing? Should this course be adopted in fact? To make use of applied entomology, we begin by studying the subject along general lines, and useless indeed would those efforts be which were made to fight against insects, and not based upon the biologic principles peculiar to this class. Without wishing to state that we can apply Virgils words "Ab uno disce omnis" unrestrictedly, we may nevertheless make the statement that the knowledge of the habits of one insect guides us to knowledge of others.

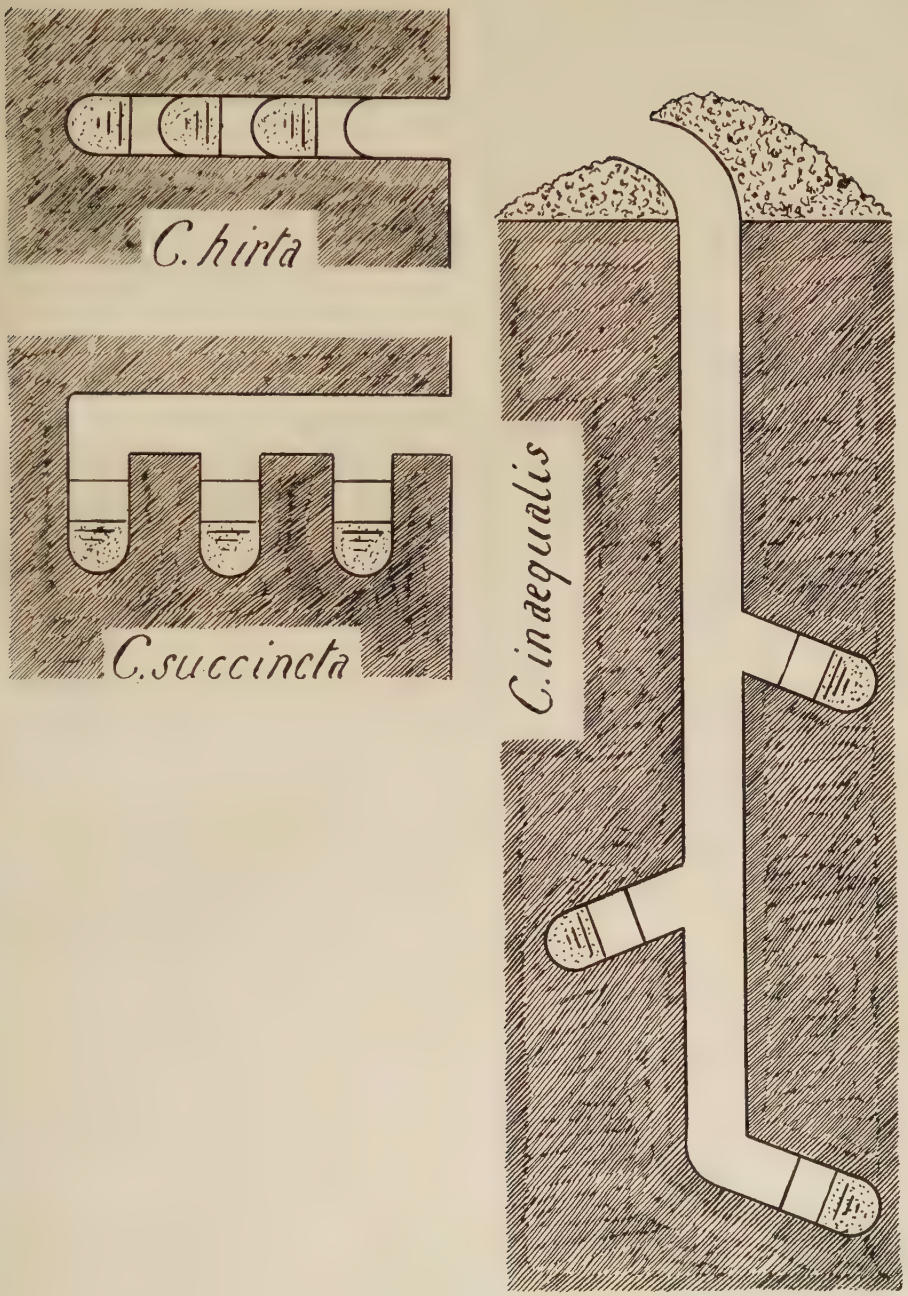
Again, in the pursuit of one particular line of enquiry, we are inevitably led to make observations bearing upon others of a totally different order. Should we neglect them on that account? It seems to me that we have no right to do so, for in the Natural Sciences where the field is so vast and our knowledge so lamentably fragmentary, facts which have escaped the notice of one observer may perchance be recorded by another; whilst those things which are negligible for one become for another the starting point for the most important researches.

It would, however, be unjust to regard insects as a class only as our enemies. Without doubt their ravages are important, incalculable even, but among their number are some which we look upon as precious auxiliaries, allies, who, far from being harmful to our interest, work for them in concert with us.

Bees, particularly, are they not of inestimable value to us in the work they do when passing from flower to flower, to ensure pollination by this means, and thus the reproduction of vegetable species? I do not think, therefore, that I am departing from the true aim of the Society, in presenting some notes upon one of our indigenous bees, *Colletes inaequalis* Say *propinquus* Cr. *canadensis* Cr. The Colletes belong to the group Podilegidae, those bees which bear the pollen collecting apparatus upon the tarsal joints. This genus contains a very modest number of species, in comparison with its neighbour, the genus Andrena which includes some hundreds. Like honest workers, they cannot afford the luxury of fine attire; their costume is made for work, sombre in ground colour, only relieved by light coloured bands upon the abdominal segments.

They vary in size, but are as a rule rather more than medium, the species

PLATE VIII



Underground nests of Colletes

which especially concerns us being 12-13 mm. They resemble the *Andrenidae* somewhat in general form, but differences in character, particularly in their wing venation, enable the two genera to be easily separated.

One peculiarity, which has given the Colletes an unique place among the Apidae, may be appropriately mentioned here. Alone among all other bees, they line their cells with a viscous substance, which on hardening forms a silky membrane, a sort of transparent skin. This fact has given rise to the German name, "Silk Bees."

The biology of these little insects is extremely interesting, the construction of their nests in particular presenting important variations. At the commencement of my studies on bees, I became accustomed to look upon the construction and disposition of the cells as entirely a generic character. Different observations have proved to me, however, that the contrary is the case. I cite as an example *Angochlora pura*, which builds its nest in old stumps and constructs the cells with sawdust, whilst another *Angochlora* species builds in the earth, using sand. Then again, while the *Anthophorae* build their nests as a general rule in subterranean galleries, *Anthophora terminalis* utilizes the branches of sumach, or the trunks of trees. The Colletes furnish another example of the diversity which can exist in the next construction of different species.

According to the forms of the galleries, three forms of construction can be distinguished among them:

1. A vertical pit, with side branches.
   Ex. *C. compacta* and *C. inaequalis* in N. America.
2. A horizontal gallery with vertical branches.
   Ex. *C. succincta* in Europe.
3. A simple horizontal gallery.
   Ex. *C. hirta floralis* and *marginellus* and the majority of the other European species.

This latter form of construction is remarkable for its ingenuity, the cells are laid down one after the other, exactly similar to those of a Megachile, or to give a simile of a more ordinary nature, like the cartridges in the magazine of a repeating rifle. The cover of each cell forms the floor of the following one, and in this way the bee reduces the preliminary labour to a minimum, and can concentrate all her attention in harvesting pollen and oviposition. What gradation, "what progress is realised from one species to the other." It is a magnificent example of evolution, and a confirmed follower of Darwin would not lose the opportunity of drawing weighty conclusions therefrom. The explanation is simple indeed. Our indigenous Colletes are still in the last rank of the genus. The digging of a deep

burrow absorbs nearly all their energies, and as a result very few cells, three or four at most, can be furnished, provisioned and populated. The accessory task has become the major one, and essentials are neglected.

Colletes succincta goes a step further. One day a mother hastening to oviposit, and not finding a favourable spot for the construction of a vertical burrow, but finding a stone wall to hand, adapts herself to this environment and pierces a horizontal gallery. The cells which in the first instance were to be found arranged radially around a central axis, are here, by virtue of the nature of the gallery, thrown down into a single vertical arrangement.

Finally a third Colletes, more knowing than the others, says to herself that these branches only mean loss of time, and useless expenditure of energy. She therefore does away with them, and builds her cells one following the other, saving in this way an enormous amount of time and labour. Is not this evolution logical? It would appear so, but one small point is lacking, which is a vital one in this case, and that is to prove that there really has been a process of evolution from the vertical form of nest to the more perfected horizontal form. This proof has never been forthcoming, and probably never will be.

But let us leave speculation and describe briefly the habits of *Colletes inaequalis*. These insects make their appearance during the first days of spring, towards the third or fourth week of April. Last year (1918) I observed them hatching about the 18th of that month. Large patches of snow still covered the ground, and the first rays of the sun have hardly had time to warm up the earth sufficiently to carry down to the depths the news of the return of fair weather, when our bees are already awakening from their winter sleep, those which, as we can testify, have passed the winter in the adult state. They move restlessly about in their narrow prison, bite a hole in the fine pellicle of their cell and dig a tunnel through the thick bed of sand, up to the light which they are beholding for the first time.

Ah! who can divine the sensations of these tiny beings when the light is reflected for the first time in their many facetted eyes; when, for the first time their tiny bodies feel the warm caresses of the sun's rays, filling them with a sense of well being and delight. For them heat and light are everything. They are the two factors, which put their whole being into motion, but let one or the other fail, the temperature fall, or the sun hide his face, and their activity suddenly ceases, more surely than if one mutilated their wings or cut off their feet. The new world which is revealed to the young Colletes, dazzles them; they cannot believe their eyes. There they are, rubbing their antennae with a stupefied air, the tarsi moving unceasingly, stroking the abdomen, a process of mutual cleansing, removing the last traces of the arduous subterranean journey.

Finally, a sudden resolve is made in an instant, and the creature sallies forth

into the unknown, to explore the horizon spread out before her, and take her place at the banquet of life.

Little time is lost, however, in frolicking in the spring air. Important duties call her. For the role of the bee is essentially that of a mother, and from her earliest days, her duty is rudely thrust before her.

With the Colletes, as with many other Hymenoptera, the phenomenon of protandry is present in which the emergence of the males precedes that of the females. The first comers, knowing the contested ground, remain near at hand. With rapid flight they scour the ground, searching those spots thoroughly, where it appears likely that a female may appear, an easy task indeed, seeing that the Colletes nest in numerous colonies.

As soon as a female shows herself she is assailed by two, three and sometimes four cavaliers at once, who quarrel over her among themselves, scramble over one another, knock each other over, unseat each other, and push and justle one another until finally they all end up in a heap upon the sand. The object of their desires takes these insistent demonstrations with a very bad grace, and often, whilst the suitors finish their quarrel among themselves, the poor victim takes the opportunity to decamp as quickly as possible. A few suitors now arrive to present their addresses. Here is one who has succeeded in ousting his rivals. His great tarsi grip the edge of the wings, the others the abdominal segments. When the chosen one protests, the mandibles seize hold of the down on the thorax to preserve equilibrium as a horseman holds on to the mane when his mount takes fright. The duration of their union varies, sometimes it is prolonged for a quarter of an hour or more when nothing happens to disturb it. The male is entirely engrossed in his business; taking a respite, he lashes in a frenzy the back of the patient one. The blows patter like hail, and then the crisis over, everything calms down, to recommence very soon again with renewed vigour.

Whilst this scene is being enacted, the female utters a small strident chirping note, the motive of which is not clear. It may be stated in passing that when mating does not take place on the site of the colony, it occurs at a definite spot, towards which the sexes flow in great numbers. I hope that the mention of such detail may be excused, but I have found out that these bees are attracted to places impregnated with the odour of uric acid. This odour may play a considerable part in those meetings of the sexes. In fact as in the case of the humble bees, the males of Colletes emit a particular odour, which is very agreable but difficult to define. One of my friends has compared it to that of Florida Water. Once on one of my excursions through the woods, I found the partially decomposed remains of a skunk, one may imagine the odour which would proceed from it. Nevertheless it seemed to attract the bees, numbers of whom were flying all around.

In a short time I was able to capture five males and one female of *Andronicus cylindrus*, eight males of *Clinodon Anthophora teminalis*, nine males of Megachile sp. and one female of *Halictus leronxii*.

The mothers once fertilised begin the work of constructing the home for their offspring. The same locality serves the purpose every year. The soil is very light, composed of fine sand and unsuitable for any sort of cultivation. As a rule the afternoon between 3 and 4 o'clock is the time chosen to begin the task of digging the burrow. The front tarsi and perchance the mandibles loosen the soil, passing it back to the middle tarsi, which in their turn pass it on to the hind tarsi. The work is eagerly pushed on. The insect works vertically, sideways, and even on its back so as to dig to more advantage. Soon the hole deepens; in a quarter of an hour the insect disappears and the work now goes on unseen. The tarsi gather the soil together and pass it back behind the abdomen. When a sufficiently large load has been collected, the Colletes reascends the narrow corridor, pushing the load up to the surface. This results in little heaps of debris, which put one in mind of a miniature mole hill, and are sure indications of the presence of a nest.

From time to time at regular intervals, an upheaval agitates the little mound, indicating that a fresh load has been brought up. There is nothing more curious than the aspect of the locality where a colony of Colletes are making their nests. The mounds rise one beside the other, sometimes by hundreds, with their fresh sand recently brought up from the depths nearby. The work continues throughout the night, and I have reason to believe is completed at the end of fifteen hours. As long as it lasts the heap of sand remains closed, for the bee does not go outside the burrow to deposit her load. The work completed, the insect excavates a passage for herself through the debris. This entrance tunnel, curved like an arc, serves so to speak as an antechamber. There the Colletes remains, morning and evening when the temperature is not high enough to invite her out of doors, and all these openings—at the bottom of each one of which a bee is watching—remind one of a stronghold, the least approach to which is jealously guarded. At first I experienced serious difficulties in the task of studying and describing the method of nest construction. Indeed, while endeavouring to follow the course of the burrow, the fine sand kept falling into the tunnel, in proportion as I dug. The idea then occurred to me to pour plaster into the orifice, as if to obtain a mould. I thought this notion an original one, and was quite proud of my invention. But there is nothing new under the sun, for I discovered later that others before me had employed the same method. In any case the method was a complete success, and enabled the construction of the nest to be easily studied. It was a difficult matter it is true, to withdraw a mould without breaking it, but by the use of sealing wax the trouble is easily disposed of. These underground habitations present the

following plan: On examination one finds that the Colletes begins by digging an approximately vertical tunnel, about 8 mm. in diameter, or that of a stout pencil. The length varies, in the majority of cases is about 30 cms., although sometimes only half that length. At this depth the tunnel bends and is obliquely prolonged for a distance of from 4 to 11 cms. At the end of this branch the bee constructs the above mentioned nest on a higher level. It is 2.5 cms. long and .8 cm. broad. The cell prepared, it is then provisioned with honey, not, however, any kind which has anything in common with that of our domestic bee. It is in the form of a rather thick and dark coloured paste, is mixed with nectar and pollen, and has an odour which is far from agreeable.

A single egg measuring 3.5 mm. x .5 mm. is fixed on to the side of the wall, slightly above the level of the honey with which the cell is half filled. When the egg is laid, an oblique transverse membrane is fastened to the wall 12 mms. from the cell base, which hermetically seals the nest. Above this, there still remains a cell case almost equal in length. The first cell completed, our Colletes commences another one. To do this she ascends slightly higher up the central gallery and without any regard to the position of the first nest she attacks a second. The soil which is removed from the new tunnel is used to fill up those parts underlying it and to isolate the first cell completely from the others. This fact explains why the nests seem to be irregularly disposed, when one digs at random, and has not the central gallery as a guide. By running plaster into the tunnel, one usually only obtains part of the structure. The presence of other lower branches is then revealed by a spur, which is prolonged for several centimetres beyond the starting point of a side gallery.

It is difficult to say how many cells can be thus furnished by a single Colletes. Indeed numerous tunnels are found on the side of a colony, and the different constructions run into one another in such a way as to make it impossible to say whether the cells one meets with belong to the same or different bees. It is perhaps nearer the truth to state that the number of nests of a single gallery does not exceed three or four; but there is nothing to show that the same Colletes may not construct more than one gallery.

Meanwhile what is the fate of the egg? Abandoned in the sand, it hatches. The young larva feeds on the reserve nourishment, grows in size, and changes into a pupa, but before transformation takes place, a precaution is taken, which does not lack ingenuity. To protect the flimsy pellicle in which it is imprisoned for long months, against the cold of winter, the larva plasters the walls with its excrement. Slight in appearance as is this tenuous covering which is placed on top of the outer membrane of the cell, the fact that nature has endowed the creature with the instinct to have recourse to such a means of protection means that it must be an efficacious one. The cell from transparency becomes opaque

and dark brownish in colour. Not having been successful in rearing larvae in cages it is difficult for me to give details of the duration of the different stages of the insect.

The following, however, are several dates for 1916 and 1917—April 18 emergence from the ground; April 22nd excavation of the gallery; April 2nd and 29, mating, May 22nd egg found in cell. Small larva in another cell. August 30th and November 29th adults, pupae and well developed larvae found in different nests. This latter date, when the soil is already frozen, shows us that the Colletes pass the winter in different stages. One cannot do justice in words to the dainty appearance which these bees present, when at the end of the autumn one tears asunder the delicate membranous shroud which shelter them.

There they are, immaculate and fresh looking, in an attitude of profound meditation, the tarsi folded over on the chest, the wings perfectly developed, their little silky fleece unruffled.

Surely it would seem just that bees, so gentle and hard working as these, should have no enemies? Alas as in our human society, here also exploiters are to be found. Averse to toil they are, and they only seek how they may make profit out of the labours of honest workmen.

Flying unceasingly in the neighbourhood of the colony, they watch for the favourable moment, when the mother departs to collect provisions, to penetrate the cell, then to effect their egg laying and depart hastily, to repeat the same deed elsewhere.

Such is the case with *Sphecodes dichroa*. More than once I have seen her slipping into a tunnel in the absence of its owner; at times however, her plans go awry, and she ventures into an occupied domain. The intruder is quickly sent about her business; hustled out, knocked over and roughly handled, she is thrown out of the gallery, and departs hastily, content to have got off so easily. Others *Bombylius major* and *B. pygmaeus* act in a different fashion; as quick as lightning they flash over the site of the nest; now here, now there they fly, so quickly that the eye can hardly follow them. All at once they come to a standstill, like a fixed point in the air they hover motionless over the site of the orifice. Then in one mass they drop to the ground, hardly stopping for an instant at the entrance to the gallery. The moment of action, short as it is, suffices for the disposition of a minute egg, which in all probability the Colletes herself in her comings and goings will unconsciously suffer to remain. The study of these Dipterous parasites forms the basis of a very interesting subject, which if fortune favours me I shall pursue.

We have now thoroughly investigated the life history of *Colletes inaequalis*, her birth, diversions, labours and mishaps. But this life is a short one; those

populous cities, which in April and May present an unparalleled scene of animation, are deserted by the end of June. The little mole heaps are scattered, and the galleries have fallen in. What is the fate of the mother herself? Having accomplished the great task of assuring her posterity, there is no further work for her in her future barren existence. Child of the light and the sun, she still idles away a few days, pilfering the sweets of the flowers in the neighbourhood. Up to the last she is drunk with nectar, and when the beatings of her tiny heart are about to cease, when the first spasms of death seize upon her, she can find no better place to die than the petals of an open corolla. There we may find her huddled together in the agony of death, and like the girl who mourns for Malherbe, we may apply to her the lines of the poet,

".....elle a vécu ce que vivent les roses,
".....l'espace d'un matin.

Note—Those wishing to study the habits of other species of Colletes, may read the following works with profit.

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SOME INSECT INJURIES IN WOODLOTS

Dr. J. M. Swaine, Chief, Division of Forest Insects, Entomological Branch, Department of Agriculture, Ottawa, Ont.

Very serious and extensive insect injuries to forest trees, particularly to balsam and spruce, have been spreading for several years in the forests of Quebec and the two neighbouring Provinces. The same or similar troubles are developing in farm woodlands in various places, so that it may be worth while to describe these injuries in their relation to farm woodlots.

The Balsam Injury

There are extensive areas of forest in Quebec Province upon which the balsams are dead, dying or more or less badly diseased. The primary cause of this trouble was undoubtedly the great outbreak of the Spruce Budworm that spread over the western half of this Province several years ago. The budworm caterpillars fed voraciously upon the balsam foliage and many thousands of trees were killed outright as a direct result of this defoliation; a much larger number were so badly weakened that even after the caterpillars disappeared they were hardly able to struggle back to a normal condition, and each season many thousands of them are dying. The weakened trees are more susceptible to injury by insects and fungi, and they are being attacked by two species of insects, the Balsam Bark-beetle and the Balsam Bark Weevil, and by two injurious types of fungi, certain heart rots and a sap rot.

The Eastern Balsam Bark-beetle

Pityokteines sparsus Lec.

The adult of this species is a very small black beetle, 2 mm. in length, cylindric in shape, with sparse erect hairs, and a few small teeth on the posterior end of the wing covers. The adults, one male and several females, enter the bark of dying, weakened or healthy balsams in the early summer. Each female cuts a perfectly cylindric egg-tunnel, in diameter slightly greater than her own, and places the eggs singly in niches arranged alternately along its sides. The egg-tunnels radiate from the central nuptial chamber which together with the entrance tunnel forms the residence of the single male. Each female works the boring dust produced in the course of her excavation backwards into the central chamber where it is finally extruded through the entrance hole by the male. The whole set of egg-tunnels lies between the inner bark and the wood, scoring both. The

1—Group of Dead Balsam.
2—Tunnels of *Agrilus anxius* Gory, in Birch.
3—Balsam Bark Weevil. Bleeding spots on bark of a green Balsam.
4—Balsam Bark Weevil. Inner face of Balsam bark, showing larval mines.
5—Birch, killed by *Agrilus anxius* Gory.
6—Dying Balsam.

grubs which hatch from the eggs bore outwards away from the egg-tunnels through the inner bark and between it and the wood. The grubs pupate in the ends of their mines, change to adults, and eventually bore their way out through the overlying bark to freedom. The species is very small, but occurs in immense numbers in nearly all balsam slash and dying balsam bark. When green and apparently healthy trees are attacked the effect of the multitude of tunnels checks the sap flow and kills the tree. The latter turns red and is visible from the distance as a red tree. Probably the majority of "red top" balsams in Quebec forests are killed by this beetle. Its chief breeding ground is balsam slash from cuttings, standing trees on light burns, heavy wind falls, and large quantities of dying balsam bark produced by any cause. The species also breeds less commonly in the eastern larch or tamarack.

The Eastern Balsam Bark Weevil

Pissodes dubius Rand

This species is a small beetle about 4 mm. long, and grayish in colour. Its eggs are laid in early summer in small punctures cut in the bark of the trunk of healthy or weakened balsams. The egg-punctures are arranged in groups and the exuding balsam drys about and below the punctures forming conspicuous whitish patches, "bleeding spots," which betray the injury while the foliage is still green. The larvae excavate long winding mines between the bark and wood radiating from the group of punctures and eventually pursuing an upward or downward course. The young beetles, after maturing in the end of the larval mines, emerge through the bark early in the following season.

This injury is apparently new to the Province. It was found to be spreading rapidly in green timber in some localities last summer, and will apparently prove a serious enemy to the balsam.

The areas of injured balsam are very extensive in this Province and the loss in pulpwood has already been very great. The spruce is also suffering to a lesser degree and from similar causes. It is not intended, however, to discuss the forest problem at this time, but to point out to owners of farm woodlands the importance of checking the spread of these injuries in their woods. Both injurious insects and fungi breed in the slash of all our timber trees as well as in any dying bark and wood, from windfalls or any other cause. It is, therefore, most important to destroy all breeding grounds of this kind, in order to protect the healthy trees. Stumps should be cut low and the remaining bark should be removed. The slash should be burned, preferably in piles covering as many of the stumps as possible; and at the same time all dying and broken trees, and those showing fungus fruiting bodies, "Conks," on the trunk or branches should be

treated in the same way. It is of the utmost importance to get rid of the slash and dying trees, that great breeding ground for boring insects and parasitic fungi. In small operations, carried out on farm woodlands, slash burning is entirely feasible and can be completed with very little expense.

It is perhaps more important to give this careful attention especially to the softwood trees, balsam, spruce and pine, but all our hardwoods, as well, are attacked by boring insects, some of which are particularly injurious, and they are very commonly injured by destructive fungi.

The condition of the white and yellow birch in parts of Quebec Province is worth noting in this connection. It was found last summer that on at least one watershed in Quebec the white and yellow birches were dying in large numbers from attack by the well known enemy of birch shade trees, the Bronze Birch Borer. It was unusual to find an outbreak of such proportions in the forest, although this insect is particularly destructive to cultivated birches. The affected trees die gradually from the top downwards. Dying tops on birches may indicate the disease; it is definitely identified by the numerous winding tunnels in the inner bark of the affected portion of the trunk. By the time the top of the tree is dead the grubs are cutting their tunnels far below in the apparently healthy bark, and cutting out the tree top rarely does more than check the disease temporarily, and then only if the top is cut out well below the dying part.

In woodlots, all birches with dying tops should be marked in the fall before the leaves are gone and these trees cut and utilized during winter. Destruction of the infested trees before June will check the spread of the beetles.

Woodlots have almost invariably to struggle against abnormal conditions, and it is only possible to preserve the health of the trees if the injurious factors are removed to the greatest possible degree. It is useless to expect healthy conditions in isolated sections of woodland if considerable quantities of dying trees, bark and wood are left each season to breed great numbers of boring insects and destructive fungi. All slash and dying wood should be utilized to the greatest advantage and the rest burned. Dying trees and those badly injured by insects and fungi should be utilized without delay. If the injurious insects and fungi were kept under control for several seasons the waste from dying trees and branches would be greatly reduced.

EFFICIENCY FACTORS IN POTATO SPRAYING

Dr. W. H. Rankin, Cornell University

Spraying late varieties of potatoes five to seven times every year with bordeaux mixture largely eliminates many of the factors which cause a fluctuation in yield. Since spraying thus furnishes a means of making a much larger profit on potatoes, no potato grower can afford to neglect this rather simple but sometimes distasteful practice in this section of Canada and adjacent United States.

The accuracy of these assertions is no doubt already well recognized by the majority of those present. Where proof is desired, however, we need only refer to the experiments conducted for a period of twenty consecutive years at the Vermont Agricultural Experiment Station, and the ten year experiment in New York State. In the Vermont experiments the yield was increased 116 to 224 bushels to the acre by spraying in years when late blight was destructive.[1] Even in years when there was no late blight, an average increase of 66 bushels to the acre was realized. In the New York ten year experiment an average increase of 45 to 97 bushels to the acre was obtained. This increase is realized not only by the expert, but by the average grower as well. One hundred and fourteen New York farmers reporting definite figures on costs and results showed an average increase in yield of 36 bushels to the acre. Two hundred and four farmers reporting only on yield showed an average increase of 54 bushels to the acre.[2] These results mean that the farmer received on the average every year in money returns over three times the total costs of the spraying.

Despite the decided advantages in favor of every potato grower spraying every year, many do not spray. It was in view of this fact, and also because there are many factors in potato spraying which need emphasis that I have have chosen this subject tonight. Before proceeding with the discussion of some efficiency factors in potato spraying, it is necessary that we call to mind certain facts regarding the troubles which spraying helps to control.

No matter how free the crop may be from the many diseases which are carried over from year to year in the tubers, the late potato varieties in this climate are subject to injury by early blight, late blight, tip-burn, the Colorado beetle and flea beetle. Considerable effort has been expended to select and breed varieties resistant to early and late blight. These measures have been largely without successful results, although many varieties of commercial importance show varying degrees of resistance. The exact combination of weather conditions in July and August determines largely the destructiveness of early blight, tip-burn and late blight. It is pertinent to observe here that the seasonal con-

ditions in this region which would leave the potato practically free from all three of these troubles are so rare as to be the exception. In other words, a given season is either favorable in varying degrees to the development of early blight, and tip-burn or is favorable to late blight. That is the reason why spraying properly done will always pay for itself.

Early blight, caused by the fungus, *Alternaria solani*, is a disease of the foliage only. New infections apparently originate in the spring from spores which over-winter in the soil. For the destructive development of this disease, there must prevail frequent wet and cloudy weather during the month of July, followed then by a period of generally high temperatures in August. The moist periods of high humidity and abundant rains in July are necessary to promote a rapid succession of infection cycles; this results in general infection throughout the fields. High temperatures following such general infections are favorable to the rapid growth of the mycelium in the leaves and to the consequent killing of the large circular areas of tissue. It is interesting to observe that although the plants may be generally infected, hot weather is necessary for maximum destructiveness. On the other hand if no prolonged rainy weather precedes the hot weather but little early blight appears.[3]

Tip-burn, a physiological disease, as yet not fully explained, is probably due to over-transpiration which causes the wilting and death of small areas of leaf-tissue, usually near the tip of the leaf. High temperatures either in July or August may bring a destructive development of this trouble. Tip-burn may appear in the absence of early blight and, therefore, is probably little affected by the presence or absence of previous rainy periods.

Late blight is very definitely associated with certain sequences in weather conditions. The early seasonal development of the late blight fungus, *Phytophthora infestans*, is still largely shrouded in uncertainties. The fungus may affect the tubers in late autumn, but the prevalence of tuber-rot is not as directly proportional to the amount of foliage blight as might be expected. Considerable foliage blight may be accompanied by a relative absence of tuber-rot and *vice versa*. The role that affected tubers play in the primary foliage infections the following season is problematical. Affected tubers rarely produce many sprouts, which reach the surface of the ground and those that do are weak and soon die. Close observation and experiments show that but few such sprouts are capable of producing spores above ground, therefore it is doubtful if they are responsible for primary infection cycles in the late spring.[4] It must not be overlooked, however, that even weak and short lived sprouts from slightly affected tubers may produce conidia below ground. These may then account for zoospores which may cause infection by splashing onto the low rain-beaten foliage of nearby vines. Either by this possible means or by over-wintering oospores in the dead leaves or

by some other means, the fungus obtains a start on the new season's crop. It is interesting to note at this point that it apparently makes little or no difference how prevalent the fungus may have been the previous season. Successive seasons when no late blight can be found may be followed by severe epiphytotics provided the necessary predisposing weather conditions prevail during that season. As to the successive stages by which the blight spreads in the field during June and July there is little known. It is difficult to find any evidence of its presence at this period, although so far as one can judge the same weather conditions prevail which are accompanied by severe epiphytotics in August. The fungus must be passing through successive cycles, however, or it would be difficult to account for its almost uniform abundance and quickly destructive attack over large areas in August. The important correlation between weather conditions and blight epiphytotics occurs after the blooming period and usually after the first of August. For a primary epiphytotic several days of high humidity, accompanied by intermittent rains and cloudy weather, together with a low temperature (52-73. Fahr.) are necessary.[5] The intensity of the attack will vary with the degree of humidity, range of temperature and the duration of these conditions. If this period is then followed by shorter or longer periods of the same conditions, progressive development often results in total destruction of the tops. Direct losses thus result from low yield and more or less rot of the tubers.

After this brief review of the factors at work in the potato field for the control of which spraying is necessary, we may now consider some of the factors which determine the effectiveness of spraying. A little attention paid to the proper methods of making and applying bordeaux mixture will insure the maximum return for the investment of labor and material.

Bordeaux mixture is by far the most satisfactory substance to use on potatoes. This mixture consists of colloidal plates or membranes inclosing lime particles, lime particles in suspension and all contained in a strong solution of calcium hydroxide and calcium sulfate. The composition of the colloidal membranes is doubtful, but they are probably a complex mixture of basic copper sulfates. The important fungicidal properties of bordeaux mixture are due to the number and size of the colloidal membranes and to the lime particles. When the mixture dries on the leaves the colloidal membranes and lime particles adhere tenaciously to the surface of the leaf. In this condition the copper and lime remain effective for a long time. After once dried the particles will not wash off.[6]

The strength of the mixture is a matter of choice to a certain extent. It is doubtful if a mixture stronger than 4-4-50 or 5-5-50 is required. The strength 5-5-50 has been found to contain at least twice the number of colloidal membranes that a $2\frac{1}{2}$-$2\frac{1}{2}$-50 mixture contains. Stronger mixtures are, however, proportionately wasteful of materials since the membranes are much thicker and do not

give the same relative covering power on the leaf. Vigorous stirring while pouring the dilute copper sulfate solution and lime milk together is necessary to produce the maximum number of thin membranes and thus obtain the greatest covering power. At the same time a mixture containing these small, thin membranes will be easier to keep from rapid settling and thus make possible a more even distribution of the membranes throughout the field. No amount of agitating will yield good results when concentrated solutions are poured together.[6]

The mixture is effective as soon as it has dried on the leaves. The copper in the membranes is slowly dissolved when the leaves become wet. The lime particles are also fungicidal. In making an application it is necessary to obtain a uniform distribution of finely divided mist-like particles of the mixture on the leaves. If the sprayer does not develop a high pressure the drops will be large. The mixture will then run off the leaves and the coating of colloidal membranes will be uneven and much less efficient. The leaf need not be entirely covered by the mixture, however, even under the best of conditions, for should a spore fall on the leaf even at a distance of one-sixteenth of an inch away from a sprayed area the germination of the spore is retarded. From what has been said one will readily recognize how important the proper methods of mixing and applying the solution are in determining its efficiency.

All the well planned experiments have shown that while three sprayings will often yield paying results, sometimes, however, they fail, due to the fact that they were not applied at just the time required by the conditions of that season. Therefore because of this showing, the advisability of spraying is often condemned or doubted. We have only to analyze the things accomplished with from five to seven sprayings to understand why this practice is successful and why a less number of sprayings may result in disappointment.

The first application should be made when the plants are six to eight inches high, or at least soon after this stage in their growth. While this application is largely advised to carry the bug poison; the mixture has then an excellent chance to coat the leaves which will soon be over-grown. Also this early application may aid considerably in reducing the amount of primary infection. It is then necessary to spray at least every two weeks thereafter until frost if the maximum benefits are derived. This frequency of spraying is necessary because of the new growth made by the vines after each application, and this in turn must be coated. The older leaves, after the vines become dense, are not reached by the later sprayings, but the coating they received probably remains effective the entire season. The successive applications which keep the leaves coated with the colloidal membranes and lime particles accomplish the increased yields in the following manner[6]:

1. The spores of the early and late blight fungi, which are wind and insect

borne, are killed by contact with the colloidal membranes giving off free copper, or by the alkaline solution derived from the lime particles.

2. The germination of the spores is inhibited or retarded when they lie close to either the colloidal membranes or lime particles.

3. Tip-burn is prevented to a large extent in a manner that is not fully understood.

4. Flea beetles are repelled and the number of punctures reduced.

5. The plants live out a normal indeterminate growth until killed by frost. This period of lengthened growth often reaches two weeks, and results in a larger number of first class tubers.

The next most important factor influencing the efficiency of spraying is the time of application with reference to rain periods; this is especially important at the stage in the development of the potato when late blight causes its heaviest losses. Since new outbreaks of blight can be correlated definitely with rain periods of the proper character, spraying should be done before such rain periods, if it is possible to predict their arrival. This insures that all the new growth up until the rain period is covered. Infection which would be accomplished during the rain period is thus prevented to a large extent.

Even after there is little danger of late blight killing the tops in time to reduce the yield, it is advisable to continue the spraying, since heavy tuber infections may follow relatively unimportant late foliage infections.

The advantages of spraying are so apparent, and the procedure so easy of successful application, that it is unfortunate that growers of small acreage find themselves hampered in many ways from adopting the practice. It is because of this fact that I want to outline a simple scheme of cooperation which will largely avoid the objections of the small grower, and at the same time probably more efficiently accomplish the best results.

The most important reason why small growers do not spray are, first that the investment in machinery and materials is prohibitory and, second, that the amount of labour involved throughout the season seriously interferes with the necessary care that other crops demand. It is with a view to removing these difficulties, which must be overcome to extend potato spraying, that the following plan is suggested. This method may be called community or cooperative spraying:

A single efficient potato sprayer will take care of 100 or more acres of potatoes according to weather conditions. In regions where each grower raises ten acres or less a single machine will thus serve for several fields and reduce the investment.

By simply passing the machine from one grower to another, many difficulties

may arise. Spraying is not like threshing or wood cutting, the work must be done at certain definite times. The responsibility for the care of the machine, and its availability to each grower when it is needed is too uncertain. Also the labour difficulty is not solved. By adding a man and team of horses to the community machine, however, the equipment can be made more efficient and workable. The service of the spray machine is then obtainable by contract for the season at a definite charge for the acre. To obtain the most from such an arrangement the following suggestions are made:*

1. The sprayman should be reliable and should thoroughly understand the methods used.

2. The sprayman should provide the sprayer, team and spray materials, and charge a certain price for an acre for each application.

3. The sprayman should be required to use a recommended formula (5-5-50 or 4-4-50), to spray at certain intervals (10 to 15 days) and to spray a certain number of times (at least 5).

4. Growers wishing to have a stronger mixture, more frequent applications and a greater number of applications would of course have to pay more for the sprayer's service.

5. All of these matters should be contained in a written contract between each grower and the sprayman.

6. The grower should provide convenient facilities for securing water and at least 4 good tight 50 gallon barrels for mixing purposes.

7. The sprayman should be careful not to engage too large an acreage. Weather conditions may cut the available time for spraying to one-half of the total number of days necessary to make a circuit of the fields. One hundred acres is probably all that should be handled. The territory covered by his contracts must be limited also, or much time will be lost in getting from one place to another and thus the charge will be higher.

If there is no energetic person willing to organize the community and secure contracts and himself do the spraying, the organization can be perfected by the community itself. Then some one man or a committee acting for the growers wanting the service can hire the labor, buy the machine and arrange the spraying schedule.

The advantages of such a cooperation, besides furnishing the spraying at a minimum cost, are that a single individual doing nothing but spray potatoes,

* F. C. Stewart, Botanist of the New York Agr. Exp. Sta. collaborated with the writer in formulating this plan of community potato spraying for the New York Food Supply Commission in 1917.

ought to become more efficient. It seems possible that industrious students from this College might be interested in undertaking this sort of work in the communities where they live. At any rate some cooperation could no doubt be arranged by which Macdonald College or the Dominion Botanist would furnish aid in starting the community organization, and later provide for technical advice to the spray-man so that the best results may be assured.

In conclusion, I wish to suggest that this Society might well undertake the advancement of some propaganda for more and better spraying of potatoes in Quebec. At the same time in localities where conditions make it feasible, either community organizations should be encouraged or some individual interested in taking up potato spraying as a specialty. The plant pathologist can offer you no better or less complicated means of insuring any crop against losses due to disease than they have now crystalized in the accepted directions for spraying potatoes.

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HOW THE PROTECTION OF PLANTS HAS PROGRESSED IN QUEBEC

Geo. Maheux, Provincial Entomologist, Quebec

A slow progression towards improvement is the characteristic of any work of scientific generalization. Conflicting continually with old prejudices, ever opposing the freaks of a deep-rooted habit, having to demonstrate its efficiency by examples not always to be found easily on the spot, slowly penetrating into minds who never accept an innovation without a pledge, its ascent, delayed by these agents, sometimes follows a line, the elevation of which is hard to appreciate. Such a work as that followed up for the past ten years by this Society and by the Department of Agriculture for six years now is too practical to have failed to spread gradually among the ranks of our rural community. It is well to glance behind us to see the path that has been followed: a moment's observation will show us the distance now separating the starting point from the present state, and perhaps it will give us more courage to continue with a new impetus the work undertaken. I will not go into all details of this progression generally witnessed in the methods used for the protection of plants in this Province; you are all aware of the conditions prevailing in this respect ten years ago. Except for a few orchards owned by progressive people, and where sprays used to be made, the protection of plants solely consisted in the application of Paris green on potatoes, here and there, and then only to control Colorado potato beetles. Has a marked progress been achieved during this decade? This we shall see further on.

From many standpoints, the year 1918 will be remarkable in the world's history. It is, we might say, the golden age of Canadian agriculture; in a splendid effort for increased production, the noble race of the humble tillers of the soil has largely contributed to save the world from starvation, in making the Canadian soil yield crops never seen before. In the Province of Quebec alone, nearly three-quarters of a million acres of land were put under cultivation in excess of the previous years. You are not unaware of the magnificent impetus given to the agricultural question, as well as of the complete organisation created by the Department of Agriculture to support the enthusiasm, stir up the energies, to rouse and keep emulation up to the end.

Invaluable services have been rendered to the Province by the Greater-Production Service. None of the questions relating to the production of food for immediate consumption has been neglected by its chief, Dr. Charron. Its or-

ganisation and its means of immediate communication with farmers were kindly put at the service of entomology.

Thanks to this agreement, the purchase of insecticides and fungicides was made in bulk by the various parish committees installed in over 800 rural municipalities. Circulars and bulletins on the protection of plants were distributed through these committees closely connected with parties interested. On the other side, all minds were prepared and roused by a publicity campaign regarding the damage caused by pests, the benefits of spraying and various treatments; all the newspapers have contributed in spreading these indispensable elements throughout the Province. Several circulars on sprays giving the price of chemicals, etc., were mailed to each committee. We had besides published two posters, colored and illustrated, giving full information for spraying vegetables and fruit trees; after a few weeks, none were left for distribution, a proof that farmers have realised the necessity of protecting their crops in an efficient manner. Instructors and lecturers, together with the District Representatives, have kept the sacred fire burning during the whole summer, and they have helped greatly towards ensuring the final success.

What has been the result of all this work in so far as the protection of plants is concerned? We must frankly admit that results have gone considerably beyond our expectations. Within one year we have made more progress in this respect than during the five years previous. At first, the most important feature, the habit of spraying, as you know by experience, was progressing very slowly in rural districts. Owing to the impulse of circumstances, it has spread to such an an extent that more than two-thirds of the farmers have introduced this practice into their farming system. Now, in this matter, the start is the most difficult and afterwards the work is repeated automatically; the work is popularized, and this alone is a very great result.

Here are a few figures which will give you an idea of the insecticides and fungicides used in the Province during 1918.

Paris green 225 tons; Lead arsenate 120 tons; Formalin 18 tons; Bluestone 15 tons.

Let us mention here two new cases where the practice has generalised. First is the treatment of cereal seeds and potatoes with formalin which was practically not done before; in the second place, the spraying of potatoes with poison bordeaux mixture, only practised on a small scale up to that time. It is well to state that all farmers did not use these two fungicides, but a fair proportion which it is hard to figure out exactly had recourse to these remedies for the first time in 1918.

I do not think we shall fail to progress; this is only a seed put into the ground, and which will not fail to yield excellent fruit within a few years. The example of those who have gone forward will soon make the defaulters follow. To con-

firm this statement I will mention a result which has been obtained in the vicinity of Quebec. It is a question of neighbouring fields sprayed in various ways by their owners. The results are very different as you will see.

Number of Sprays	Bushels sown	Bushels harvested	Yield for one	Return in money from 1 bushel (Valued at $1)	Gross receipts $1.00 per bushel
None.....	15	50	3.3	$3.33	$50
1 spray.....	15	100	6.6	6.50	100
2 sprays.....	12	150	12.50	12.50	150
3 sprays.....	6	100	16.60	16.50	100

Needless to say that neighbours who have not sprayed, and who are now convinced by this example, will not fail to do so this year. Moreover the requests made to the Horticultural Societies for sprayers are three times more numerous than they were before: another proof of the work done in the mind of the farmers since 1917.

From the last statistics, the yield in potatoes amounts to 147 bushels to the acre, compared with 80 bushels last year. This is an increase of 67 bushels. Part of this surplus is certainly due to spraying; but let us be fair, the weather and and other agents have favourably influenced the growth, if we were to share it too, each side would have $33\frac{1}{2}$ bushels. Now, $33\frac{1}{2}$ bushels multiplied by 264,870 acres under cultivation gives the fair surplus of 8,873,145 bushels, due to the treatment of seed grains and to poison Bordeaux mixture sprays. In figuring the potatoes at $1.00 per bushel, we would have a profit of $8,873,145.00, which we think is quite an appreciable result showing better than anything else the efficiency of the methods of control.

You no doubt remember that last year, on the occasion of our Spring Meeting, I had the pleasure to communicate to those present the plan of a proposed entomological or "plant protection" campaign, which I intended to carry out during the summer. I must state that none of the articles in this programme have been neglected and that our efforts have not proved useless.

In conclusion I might say that our work, although often disappointing, sometimes affords satisfaction. For ten years now, your Society has scattered the good seed all around; we have endeavoured to reach the same end during the past few years. Results have not always been apparent, except in orchards, but at this date, we can look behind us without fear of being deceived, but with satisfaction. This does not mean to convey that the campaign has come to an end; no, but it is now in the right way and can be followed up quickly. With your assistance, we expect to be able to record a big advance in 1919.

INSECT CARRIERS OF PLANT DISEASES

E. Melville DuPorte, Macdonald College

There are many ways in which insects affect the health of plants. The work of those insects which destroy the foliage, bark, wood or roots is well known, as is also the work of those which suck the sap. Some insects produce galls, contortions or discolourations; others interrupt the circulation by ringing the twig, or in some other way disturb the normal metabolism of the plant. These all cause direct injury; but there is a method more insidious and not so well known by which insects may cause serious injury to crops, and that is by carrying or aiding in the spread from plant to plant of the germs of bacterial or fungous diseases of plants. This paper will deal exclusively with this last aspect of the question.

How Insects Spread Disease

If we examine the methods by which disease may be spread among plants, through the agency of insects, we find a general similarity between these methods and those by which disease is spread by insects among men or other animals. The following summary brings out this similarity.

1. The pathogenic organism may undergo a part of its development within the body of the insect. This raises the question as to whether the same disease organism can normally attack both an animal and a vegetable host. The question, which is an important one from the standpoint of human health, has not been extensively studied, but results thus far obtained by investigators have been for the most part negative. A note-worthy exception is the fact that Johnston[1] has discovered that the causal organism of the bud rot disease of the cocoanut is a bacillus, indistinguishable from *B. coli* which lives in the intestines of man and other animals. *Ophionectria coccicola*, a fungus parasite of scale insects, has been observed by Noack to pass from the scale insects to orange twigs causing gummosis. The only case known to the writer in which the evidence indicates that an insect may serve as a host of an organism normally parasitic on plants is that of the beet-leaf-hopper *Eutettix tenella* which spreads the curly-leaf disease of beets in the southwestern states.

2. The insect may introduce the disease directly into the tissues of the host. Insects feeding on diseased plants may carry the disease germ on their mouth-parts or bodies and introduce these into the tissues of healthy plants, through the punctures or burrows made in feeding, or oviposition. Many diseases are thus spread.

[1]Johnston, J.R. Is Bacillus coli ever a plant parasite? Phytopathology I, pages 97-99, 1911.

3. The insect may be a simple mechanical carrier, that is, it may carry the germs on its body from diseased to healthy plants and these germs may be mechanically brushed on to the surface of the latter. The efficiency of this method depends on the ability of the pathogen to enter the tissues of the host through the epidermis of leaf, flower or twig, or on the accident of the germs being deposited on adventitious wounds.

4. The insect may by injuring the plant tissues provide points of easy entry for disease germs which may be carried by the wind, insects or other agency.

The Beet Leaf-hopper and the Curly Top Disease

For many years the beet crop of the South Western United States has suffered from a blight known as "curly top," the characteristics of which are thus briefly summed up by Ball[2]. "The first symptoms of 'curly leaf' or 'blight' of the beet is a thickening of the smaller veinlets of the leaf, giving it a roughened appearance on the underside. This is followed by a curling of the edge and a final rolling up of the leaf, the upper surface always being rolled in. As this progresses the small veinlets grow still larger and more irregular, knotlike swellings appear at frequent intervals, and in extreme cases little nipple-like swellings appear, extending to a height of nearly one fourth of an inch . . . The beet almost stops growing and a large number of fibrous roots are sent out. These roots are not confined to two irregular lines as in a healthy beet . . . In bad cases it shrivels and dies . . . The sugar content remains very low."

Ball[2] and Shaw[3] were the first to connect this disease with the presence of the beet leaf-hopper *Eutettix tenella* Baker. By enclosing beets with this insect in hopper-proof cages, they were able to reproduce the disease, but their evidence was not absolutely conclusive and not universally accepted. Smith and Bonquet[4] repeated their experiment with similiar results. In addition, they planted sugar-beet seed in four-inch pots; two plants were allowed to grow in each pot, and the whole kept "in a Eutettix-proof cage from the first. After each plant had about eight or ten leaves, a single insect was confined in a vial upon one of the two plants in each pot. In each case the plant thus infected showed the typical disease after the usual incubation period (about two weeks in the greenhouse), while the other in the same pot did not.

"In applying the insect for different lengths of time it was found that as short a period as five minutes is sufficient to produce the disease."

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[2] Ball, E. D., The leaf hoppers of the sugar beet and their relation to the "curly-leaf" condition. U. S. D. A., Bur. Ent. Bul. 66, pt. IV, 1909.

[3] Shaw, H. B. The curly top of beets. U. S. D. A., Bur. Pl. Ind. Bul. 181, 1910.

[4] Smith, R. E. and Bonquet, A. New light on curly top of the sugar beet. Phytopathology V, pp. 103-107, 1905.

The same writers described a typical lesion in the vascular bundles of infected plants and isolated an organism agreeing in characteristics with *Bacillus dianthi* Bolley. They, however, failed to re-infect with this organism. Later[5] they confirmed the presence of the bacillus,but found that it was present in cases where the typical curly-leaf symptoms did not occur. They also showed that insects from certain wild plants would not produce the disease until they had fed on infected plants, and this was soon after confirmed by Bonquet and Hartung[6] by means of more extensive experiments. The insects used in these two investigations were obtained from *Atriplex*, *Chenopodium* and *Artemisia*.

Bonquet and Stahl[7] later found that the round-leaf mallow (*Malva rotundifolia*) might also serve as a host for the causal organism of the curly-top disease and that the leaf-hopper is able to transfer the disease from the mallow to the beet, or vice versa.

Perhaps the most interesting fact disclosed by the investigations of Smith and Bonquet[4] is the necessity of an incubation period in the body of the insects before they can transmit the disease. "The insect is not immediately pathogenic after the act of feeding, but a period of at least twenty-four hours, but certainly not much more than this, must elapse before it can produce the disease."—This evidence clearly indicates that the insect is not merely a mechanical inoculator, but may serve as a true host of the curly-top organism.

Insects as Passive Carriers

a. *Direct Inoculators*

Sucking Insects an important agent in the spread of fireblight. The evident connection between the prevalence of certain insects and the spread of fireblight in orchards has long been recognised. Jones[8], of the Ontario Agricultural college, was the first to definitely prove the instrumentality of aphids in spreading the disease. Stewart[9] showed that a pure culture of the causal organism (*Bacillus amylovorus*), smeared on the uninjured leaves of young pear plants, did not produce the disease except in the case of those plants on which he placed the

[4] Smith R. E. and Bonquet, A. New light on curly top of the sugar beet. Phytopathology, V, pp. 103-107, 1905.

[5] Smith and Bonquet. Connection of a Bacterial organism with curly leaf of the sugar beet. Phytopath. V, pp. 335-342, 1915.

[6] Bonquet, P. A. and Hartung, W. J. The comparative effect upon sugar beets of *Eutettix tenella* from wild plants and from curly top beets. Phytopathology V, pp. 348, 349, 1916.

[7] Bonquet and Stahl. Wild vegetation as a source of curly top infection of sugar beets. Journ. Econ. Ent. X, pp. 392-397. 1917.

[8] Jones, D. H. Bacterial Blight of apple, pear and quince trees. Ont. Agr. Col. Bul. 176. 1909.

[9] Stewart, V. B. The Fireblight disease in nursery stock. Cornell, Agr. Expt. Sta. Bul. 329. 1913.

aphis (*A. pomi*). Later[10], he proved that the tarnished plant bug, ((*Lygus pratensis*) was the most effective disseminator of the disease in New York State. In 1915, Stewart and Leonard[11] added four bugs to the list of proved fireblight carriers. These were *Adelphocoris rapidus* Say, *Campylomma verbasci* Herrick-Schaeffer, *Orthotylus flavosparsus* Sahlberg and *Pœciloscystus basalis* Reuter. Several other sucking insects have been proved to spread the disease, and it is quite definitely known that any sucking insect feeding on infected trees is a potential carrier. The fireblight bacillus occurs in large numbers in a sticky exudate and readily adheres to any insect which may feed on the plant. Since the bacillus, except in the case of blossom blight, can enter the host tissues only through a wound, it is evident that those insects which puncture the plant are the most effective in spreading the disease.

The European Apple tree canker (*Nectria ditissima*) is often spread by means of aphids (Descours Desacres).

Boring insects may also introduce the germs of disease directly into the tissues of healthy plants. Jones[8] collected specimens of the fruit bark beetle (*Eccoptogaster rugulosus*) from a blighted pear tree and allowed them to run over prepared agar and gelatin plates. Copious bacterial growth followed the tracks of the beetles, and of this growth thirty to seventy-five per cent was of the fireblight organism (*B. amylovorus*). He also observed that blight often developed in the immediate neighbourhood of the burrows of this insect, and concludes that the fruit-bark beetle is one means of spreading blight in both apple and pear trees.

Studhalter[12] found that the longicorn borer, *Leptostylus macula* feeds on the pustules of the chestnut blight fungus (*Endothia parasitica*) and may carry as many as 337,000 spores of this fungus on its body. As this insect often breeds in the chestnut it must be a fertile means of distributing infection. In addition to *L. macula*, Studhalter found spores of *Endothia* on the bodies of eighteen species of insects.

Leaf-eating insects may convey disease organisms on their mouthparts or bodies to healthy plants and introduce them into the tissues through the wounds which they make in feeding.

Erwin Smith[13] was able to readily spread the bacterial wilt of cucurbits (*B. tracheiphilus*) by means of the striped cucumber beetle (*Diabrotica vittata*), and he considers this insect the chief means of natural dissemination. He says

[10] Stewart, V. B. The importance of the tarnished plant bug in the dissemination of fireblight in nursery stock. Phytopathology III, pp. 273-276. 1913.

[11] Stewart, V. B. and Leonard, M. D. The role of sucking insects in the dissemination of fireblight bacteria. Phytopathology V, pp. 115-123. 1915.

[12] Studhalter, R. A. Insects as carriers of the chestnut blight fungus (Abstract). Phytopathology IV, pp. 52, 1914.

[13] Smith, Erwin F. Bacteria in relation to plant disease. Vol. II. Carn. Inst. Wash. 1911.

"they feed readily, and sometimes the writer has thought preferably, on wilted leaves which are swarming with this organism. In this way their mouthparts cannot fail to become contaminated and to serve as carriers of the sticky infection. No other means of dissemination is known to the writer, and this is believed to be the common way in which disease is distributed." Rand and Enlows[14] confirmed Smith's observations, and showed that *Diabrotica* 12-*punctata* is also implicated in the spread of the disease.

Smith has shown also that the black rot of crucifers is disseminated by the larva of *Plusia* and the slug *Agriolimax*, and that the brown rot of Solanaceae is spread by the potato beetle (*Leptinotarsa* 10-*lineata*).

b. *Indirect Inoculators*

Many insects may spread disease without introducing the germs directly into the tissues of the plant. Successful infection depends on the presence of wounds or on the ability of the pathogen to enter through stomata or water-pores, or to pierce the epidermis. A good example of this method of transmission is afforded by the spread of blossom blight (fireblight) by bees and flies. Waite, in 1891, found the bacillus in abundance in the nectaries of apple blossoms and also on the legs and mouthparts of bees, and thus established the agency of bees in the spread of this form of fireblight. His observations, by the way, were the first exact observations made on insect transmission of plant diseases. They have since been confirmed by many workers.

Infection through Insect Wounds

Many spores freely scattered by the wind or other agency are unable to enter the tissues of plants except through wounds. It is evident, then, that the numerous wounds made by insects—feeding punctures, tunnels, egg-laying punctures—greatly increase the chances of infection, and it has been shown again and again that disease very frequently enters through such channels. Stewart and Eustace[16] pointed out that infection of raspberry canes with the cane-blight (*Leptosphaeria coniothyrium*) often takes place through the egg punctures of the striped tree cricket (*Oecanthus nigricornis*). The writer has also on many occasions made the same observation.

Parrott and Fulton[17] showed that in the apple the punctures of the allied snowy tree-cricket (*Oe. niveus*) serve as points of infection for the same disease.

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[14] Rand, F. V. and Enlows, E. M. A. Transmission and control of Bacterial wilt of cucurbits. Journ. Agr. Res. VI, pp. 417-434.

[15] Stewart, F. C. and Eustace, H. J., N. Y. Agr. Expt. Sta. Bul. 328. 1910.

[16] Parrott, P. J. and Fulton, B. B. N. Y. Agr. Expt. Sta. Bul. 388. 1914.

The spores of the brown rot fungus often enter through curculio punctures. The trichosphaeria disease of sugar-cane enters through the tunnels of the various cane borers.

Do Insects Carry Disease Germs over Winter?

The possibility of hibernating insects carrying disease germs over winter has attracted considerable attention, but the only definite work known to the writer in which the results were partially positive is that of Rand and Enlows[17] on the striped cucumber beetle and the cucurbit wilt organism. They proved that the bacillus will remain viable for at least six weeks when the insect is hibernated in cold storage.

The writer has attempted to recover the spores of late blight from over-wintered potato beetles but has thus far been unsuccessful.

Conclusion

It will be observed that in the case of the beet leaf-hopper, in the body of which the curly-leaf organism undergoes some sort of development, infection is practically certain. Almost equally certain is infection from sucking insects which, shortly after feeding on some plant infected with a bacterial disease, attack a healthy plant, or from such forms as *Diabrotica* which feed equally freely on diseased and on healthy plants. Those insects which merely carry the germs from tree to tree or make wounds which may serve as points of infection are not as important a factor in the spread of disease as those which directly inoculate the plants, because of the greater elements of chance which enter into the probability of infection with disease thus conveyed, but their importance can not be disregarded.

The cases cited above do not cover the entire field of exact observation or experimental evidence on the agency of insects in transmitting plant diseases, nor do they touch upon the numerous suspected carriers, but they are sufficient to show the very important part insects can and do play in the dissemination of some of the most destructive plant pathogens. The annual loss caused by insects is usually estimated at about ten per cent. of the total crop value, but to this should be added the very considerable loss which they indirectly cause by spreading disease among plants.

A consideration of the part played by insects in the dissemination of plant diseases makes it clear that a large number of the most serious fungus diseases can be more effectively controlled by insecticides than by fungicides. This

[17] Rand and Enlows. Loc. Cit.

fact is clearly shown by the following quotation:[18] "In the apple nursery of Mr. E. D. Smith, Winona, there were some thousands of young seedlings. Very few of these were affected with the blight. On being questioned concerning the prevalence of aphids among the nursery stock, the manager stated that owing to constant supervision the aphids had very little chance to make headway. Kerosene emulsion was always on hand, and as soon as aphids were noticed on the stock every young tree affected was immediately dipped in the solution. Hence by keeping the aphids in check the disease had been kept from spreading in the nursery. The disease was prevalent in the immediate neighbornood of the nursery in every direction."

[18] Jones, D. H. Bacterial Blight of Apple, Pear and Quince Trees. Ont. Agr. Col. Bul. 176, pp. 31. 1909.

SOME COMMON THINGS ON THE FARM

Synopsis of an Illustrated Address Given to the Teachers, Children, and Parents of Brome Co.

W. Lochhead, Macdonald College

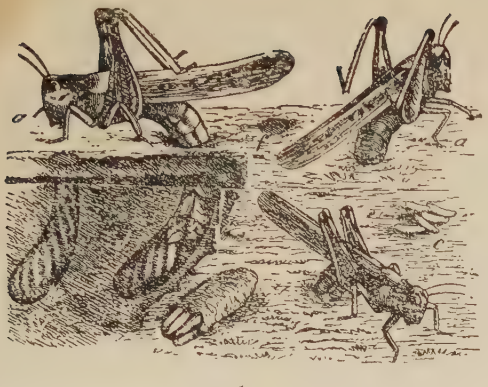
It is a common error to suppose that the farm and the countryside lack interest. In fact, it would be nearer the truth to say that more wonderful and interesting things occur about a farm than anywhere else. The animals, the crops, the soil, the pastures, the brook, the woods, the garden and the orchard all contain so much of the marvellous that our greatest scientific experts have not yet done prying into the mysteries that there lie concealed. Strange as it may seem, the most common things are often the most marvellous; and if our rural folk knew more about them they would find life on the farm not only more interesting, but also more satisfying in every way.

One reason why these common things about the farm seem uninteresting is, I believe, the lack of early instruction regarding them at shcool. The school has practically ignored them as being of little value in education. As a result the parents are also ignorant of their surroundings, and no interest is taken in such matters in the home. It is a matter of experience that persons will not remain long under conditions that are uninteresting, so this lack of interest in rural things may be one of the main causes for the rural exodus.

Children are naturally interested in the common things; and their wondering inquisitiveness should be encouraged both at school and at home, for the knowledge gained may be of great value later on in life. No normal child is afraid to handle insects, and it may be safely said that if they fear to touch caterpillars they have been given wrong information from some ignorant source. The importance of a teacher encouraging the study of the common things can hardly be over-estimated.

For generations the natural sympathies of the child towards nature have been smothered; as a result he saw but little that was beautiful in the world about him. For generations the child has been educated as a thing apart from his surroundings. Educationists had forgotten, or were ignorant of, several pedagogic principles, viz.: the senses are the avenues to the mind, and the sense perceptions give rise to definite knowledge in the mind; new thoughts can be comprehended only by the help of old thoughts; the greater the stock of ideas possessed by the child, the greater the progress the child will make in the acquisition of knowledge or new ideas; the best development is self-development, by the

PLATE X



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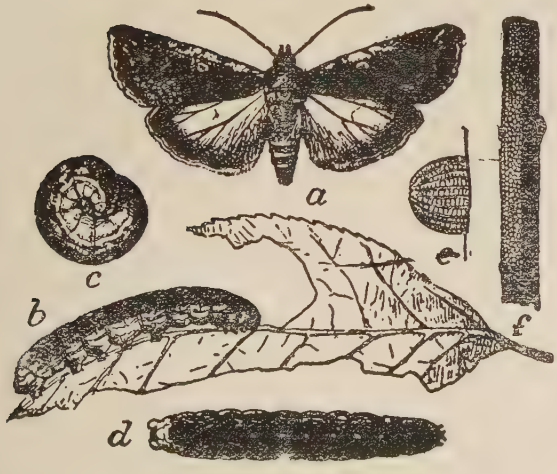

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1—Grasshopper laying eggs.
2—Wireworm, adult and grub—a bad pest.
3—Potato bettle in all its stages.
4—Cutworm in all its stages.
5—Paint-brush—a bad weed.
6—Potato Blight fungus—a bad pest.

encouragement of the activities of the child in the investigations of the problems presented to it; and education does not consist in the imparting of information by the teacher and its reception by the pupil. According to the modern idea it is all important that the child should have clear percepts of the things that constitute its environment, for these percepts form the basis for thought and further educational development.

On this occasion it is impossible to deal with all the common things that should be of interest to us all. I shall therefore, confine my remarks to a few—some common insects and fungous diseases, some weeds, some trees, the soils and the orchard.

Common Insects

All kinds of insects—good, bad and indifferent, biting insects and sucking insects, stable pests, house pests, crop pests, orchard pests—land insects, and aquatic insects—soil grubs and tree borers—leaf-eating caterpillars and root boring maggots—scavenger insects and predaceous insects— are to be found on the farm. The habits and life-histories of insects are very varied, and as the species are very numerous there is no dearth of opportunity for the inquisitive to make inquiries. When it is realized that insects cause a loss of ten per cent. of our farm produce, their study for the purpose of controlling them becomes a practical and economic measure of considerable importance. The more abundant insects are potato beetles, plant lice, house and horn flies, grasshoppers, scale insects, cutworms, leaf hoppers, cabbage worms and cabbage maggots.

The study of the changes insects undergo from egg to winged adult can be readily carried out both at home and school by using boxes in which infested plants are kept growing. The teacher should prepare a sample box or cage in school and have a small named collection of the most common forms of insect which the pupil may consult and examine at any time. Every school should possess a cheap spraying device, so that the pupils may learn to operate it Every pupil should know that there are *biting* or *chewing* insects and *sucking* insects. The former have jaws wherewith they chew the food before it is taken into the stomach, while the latter have a beak which they insert into the tissues and suck up the juices taken into the stomach. It is very evident, therefore that biting insects can be poisoned by placing a poison on the food they chew; on the other hand, sucking insects cannot be poisoned in this way and recourse must be had to placing liquids on them that kill them. Among common injurious insects that chew their food are grasshoppers, potato beetles, green cabbage worms, and other caterpillars such as cutworms and army worms. The poisons usually employed are paris green, arsenate of lead, hellebore, and these may be applied either in the dust or the liquid form. Grasshoppers, cutworms and army

worms are most effectively poisoned by the use of poison baits. Among common injurious sucking insects are plant lice, scale insects, flies, lice, leaf bugs, and the substances usually employed to kill them are tobacco extracts, soap solution insect powder, lime sulphur, etc.

There are, of course, many injurious insects about a farm that cannot be treated by either of the ways mentioned above. White grubs and wireworms which work in the soil are often troublesome where a rotation of crops is not practised, and sometimes special methods must be employed to deal with insects that cannot be sprayed or dusted.

Common Fungous Diseases

Much mystery surrounds the fungi and the diseases they produce. Fungi are plants of a low order, having no leaves, stems, or roots. They feed on dead or living organic matter and may be found everywhere. They differ much among themselves in size and structure, but may be roughly classified economically into moulds, blights, mildews, leaf and fruit spots, smuts, rusts, and mushrooms.

The fungi feeding on living plants, such as mildews, spots, smuts, and rusts cause enormous losses annually. Many of them can be controlled by spraying with Bordeaux, but others like the wheat rust and smut cannot be controlled in this way.

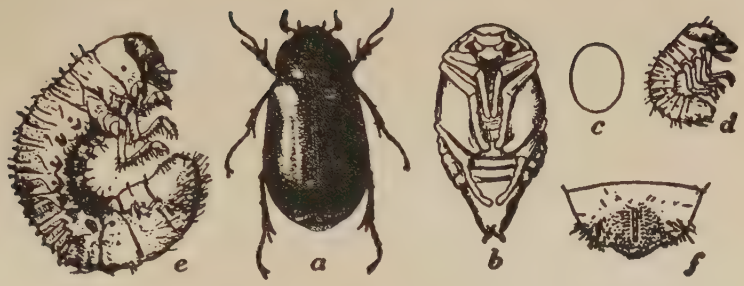
Specimens of the various types should be preserved by the teacher in the school collection and their differences pointed out frequently to the pupils. The teacher should also prepare some Bordeaux mixture so that the pupils may be able to make their own at home and apply it when necessary. Special attention might be given to the treatment of potato scab, oat smut, apple scab.

Common Weeds

This province is badly over-run with weeds which reduce crop production very appreciably. Several factors are responsible for the prevalence of weeds. (1) the lack of proper rotation of crops; (2) the lack of care in cutting the weeds before they ripen into seeds; and (3) poor cultivation of the land.

The worst weeds are Couch Grass, Canada Thistle, Ox-eye Daisy, Wild Carrot, Sow Thistle, Devil's Paint Brush, Mustard. Our school children should know the common weeds and weed seeds, and the teacher has a good opportunity of giving valuable practical lessons in the identification of the impurities that occur in seed grain, clover and timothy, and the pupils will find the exercises interesting. With this training the child may often be of service in selecting seed grain free from weed and impurities at home.

PLATE XI



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1—White grub in all its stages. 2—Wild Carrot—a bad biennial weed.

3—Hairy Woodpecker—a valuable destroyer of forest insect pests.

If the habits of the weeds are studied at all carefully in the field, the pupil will soon determine that some weeds, like lamb's quarters, pigweed, mustard, ragweed, green foxtail, are annuals and are not as a rule our worst weeds; some, like wild carrot, wild parsnip, and burdock are *biennials*; while others, like ox-eye daisy, dandelion, chicory, paint-brush, rib-grass, knap-weed, couch grass, sow-thistle, Canada thistle and field bindweed are *perennials*.

The principles of weed control are simple if these three classes are kept in mind. It is a well recognized fact that certain weeds follow certain crops and certain methods of farming. The perennials increase when meadows are left down longer than two years. The annuals are absent from such meadows, but follow cultivated crops. Perennials having creeping root-stocks often occur after cultivated crops, since their roots are often carried and spread by the cultivator and harrow.

The principles of weed control are (1) a good rotation of crops; (2) the destruction of weeds before they are able to seed; (3) the sowing of clean seed; (4) clean cultivation which includes after-harvest cultivation; (5) the cutting of weeds by the spud, scythe or hoe at the proper time; (6) using manure free from weed seeds; and (7) the keeping of sheep and other livestock to close-crop the weeds in pastures.

Common Birds

Most grown up persons in the country are sadly lacking in a knowledge of the common birds, and do not appreciate the important part they play in protecting the crops from insect enemies. What a world of interest in the study of birds! But alas, this interest had never been aroused in them as children, and outside of the robin, crow, English sparrow and a few others, the birds are hardly known. We pride ourselves in being a practical people, yet we do not take proper care of our best friends. We think more of our cats.

Without the intervention of birds, farmers would be unable to grow crops within a few years on account of the great increase in the number of insects and mice. Birds also nip in the bud many incipient scourges on account of their ability to move rapidly from place to place in search of food. Prof. Thomson says: "It is very interesting that the two great classes of successful fliers (insects and birds) should be, in the wide economics of nature, fitted against one another, wings against wings, freeman against freeman, invertebrate against vertebrate, little brain against big brain, instinct against intelligence. Practically this is the most important conflict of classes that the world knows."

The school should be a place where an interest in birds is aroused and fostered so that the people of the community may fully realize the importance of protecting these valuable agents in the control of insect pests.

Common Trees

My experience with country boys and girls who come to the College convinces me that but few know the trees that grow in the woods. Our city boys and girls are often better informed. It is a pity that such should be the case, for no feature of the country should stand out more prominently both economically and aesthetically. When we remember how important woods are for fuel, lumber, structural materials and implements, and how refreshing both summer and winter are the the trees which we know so little, we ought to feel ashamed of our education and of ourselves.

It would not be difficult to get sample blocks of the woods of the vicinity, in planed, cross and longitudinal sestions, and planed oiled lumber. Any planing mill owner would be glad to supply these for the school collection. The teacher should also aim to get the children to distingusih trees by their characteristic shapes. The practical lore of our fathers regarding trees should not be lost entirely by our generation.

The Soils

It is scarcely necessary to state that every farmer should be acquainted with the soils of his farm. He should know the characters of the various kinds of soils and recognize the fact that soils are not simply dirt. They contain not only mineral substances, but also organic matter and a host of microscopic living things that aid in keeping the soil fertile. Ignorance of these facts may soon ruin the land. Good farming presupposes a knowledge of the properties of soils.

Pupils at school could readily learn the different kinds of soils; sand, gravel, clay and peat, and their combinations. They could also study the properties of these soils with regard to their water-holding capacities, their power to draw up water, and how these properties may be changed. Some soils are getting sour or acid, and no longer grow good crops. The reason for this, and the improvement of such soils, could be taught at school. Most interesting also is the story of the origin of our soils, and some attempt should be made to get the pupils acquainted with it.

The Orchard

What is a farm without an orchard? My old friend Dr. Robertson, first Principal of Macdonald College, used to say that no family of children could be reared properly apart from apple trees and apple blossoms. How are the farmers of Quebec bringing up their children? Are they providing their children with the requisite apple trees and apple blossoms? I am afraid the children are being neglected.

A host of interests cling about the orchard, but little or no attention is given to this subject in schools. I believe we know more about bananas, figs, and pine-apples than we do about apples, plums and grapes.

Orchards require attention, and for this reason they have been a failure on most farms in Quebec. The trees should be properly selected—hardy and good; properly planted and cared for, and not simply left to grow up like so many Topsies; properly cultivated and sprayed.

The fruit grower is dependent largely on honey bees for the pollination of his orchard. This aspect of the question touches upon many matters which can be investigated by young people, such as the structure of a flower, the functions of the various parts, pollination and fertilization, the growth of the fruit and the seed, etc.

Again, every person should be informed regarding the twig and its buds, leaves and markings; important events are recorded on the twigs, and a history of the twig is a truthful epitome of the chief events that occurred during the life of the tree.

We have but touched the fringe of the land of mysterious things about the farm. Moreover, there is no danger that their number may become exhausted. These are the things that we would like to see studied in our schools. Why do we want them introduced? Because:

1. They form part of the child's natural environment which should be of interest to him;

2. A knowledge of these things would be of economic value in better farming and increased production;

3. Educationally these subjects are at least of equal importance to the old time subjects;

4. Increase of interest in these common things would prevent, to some extent at least, the alarming exodus to the city.

ABSTRACTS OF CANADIAN PLANT DISEASE LITERATURE

Edited by W. A. McCubbin

The abstracts given herein cover all the Canadian literature on plant diseases up to January 1st, 1919. There are not included in this list any articles from the Ottawa Field Naturalist, The Canadian Forestry Journal, The Canadian Horticulturist, the Farmer's Advocate, or other similar publications. The editor is indebted to a large number of Canadian botanists and plant pathologists for their assistance in supplying either abstracts of articles or the articles themselves, and it is hoped that the present list when added to the newly begun "Botanical Abstracts," will give a means of reference to practically all Canadian literature on plant diseases. It should be noted, however, that this list contains only those articles which have been published in Canadian bulletins or periodicals. Many other articles by Canadian authors, in fact the great majority, have made their appearance in other periodicals in the United States or elsewhere, and of which none are included here.

Where not otherwise stated the abstraction has been done by the editor.

Demonstration Orcchard Work Agr. Gaz. of Canada, Vol. 2, No. 3: 229-248, 1915. Summary of results in demonstration work in orchards in all the provinces of Canada in 1914.

Spraying Experiments. Agr. Gaz. of Canada, Vol. 4, No. 3: 193-214, 1917. Collected results of orchard spraying in Nova Scotia, Quebec, Ontario and British Columbia in 1916.

Special researches on grain rust. Agr. Gaz. of Canada, Vol. 4, No. 4: 259, 1917.

Agricultural Legislation. Agr. Gaz. of Canada, Vol. 4, No. 5: 408, 1917. Outline of the Federal and Provincial acts for the suppression and control of insects, pests and diseases.

The Control of Rust. Agr. Gaz. of Canada, Vol. 5, No. 10: 974, 1918. Account of the work planned or under way for rust control in Manitoba, Saskatchewan and Alberta.

Dusting vs Liquid Spraying. Agr. Gaz. of Canada, Vol. 5, No. 3: 254-260, 1918. Results from four sets of experiments on apples in Ontario and Quebec.

BARRUS, M. F., *Physiological Diseases of Potatoes.* Quebec Soc. Prot. Plants, Ann. Rept. 1917: 4553 (3 pl.). Treats briefly of mosaic, leaf roll, curly dwarf and streak. W. P. Fraser.

BEDFORD, S. A., *Smut (in wheat).* Central Expt. Farm Rept. 1890: 242; 1891: 252.

BEDFORD, S. A., *Experiments on Wheat, Oat and Barley Smuts.* Central Expt. Farm Rept. 1892: 196; 1893: 237; 1894: 289; 1896: 331; 1898: 275-282.

BEDFORD, S. A., *A Fungous Disease of Populus Deltoidea.* Central Expt. Farm Rept. 1899: 322.

BEDFORD, S. A., *Tests of Formalin and Massel Powder as a Preventative of Smut in Grain* Central Expt. Farm Rept. 1899: 300; 1900: 342, 348, 350; 1901: 409.

BEDFORD, S. A., *Smut Preventatives in Wheat.* Central Expt. Farm Rept. 1903: 318; 1904: 377.

BENNETT, JOHN F., *On the Cause of Rot in Grapes, Potatoes and other Vegetables.* Nova Scotian Journal of Agriculture 1867. Paul A. Murphy.

BETHUNE, C. J. S. and JARVIS, T. D., *Insects and Fungus Diseases affecting Fruit Trees.* Ont. Agr. College Bul. 158: 1-48 (62 figs.), 1907. Describes common insect enemies of fruit trees and common fungus diseases giving causal organism and treatment. Preparation of Bordeaux mixture and ammoniacal copper carbonate. R. E. Stone.

BETHUNE, C. J. S., *Fungus Diseases and Insect Pests.* Ont. Agr. College and Expt. Farm, Ann. Rept. 34: 24-32, 1908. Canker and gumming in peach due to brown rot. Cankers on apple trees, blight canker and black rot canker. R. E. Stone.

BETHUNE, C. J. S., EASTHAM, J. W. and HOWITT, J. F., *Insects affecting Vegetables—Fungus Diseases of Vegetables.* Ont. Agr. College Bul. 171:1-64 (58 figs.), 1909. Fungus diseases; describes common diseases of vegetables, the causal organism and treatment, preparation of Bordeaux mixture, soda bordeaux, resin bordeaux, potassium sulphide, formalin. R. E. Stone.

BLAIR, WM., *Bordeaux Mixture for the Prevention of Potato Rot.* Central Expt. Farm Rept. 1892: 187. Good results from two sprayings on five varieties.

BLAIR, WM., *Bordeaux Mixture for the Prevention of Potato Rot.* Central Expt. Farm Rept. 1893: 222. Results of two applications on 13 varieties show rather poor results.

BLAIR, WM., *Winter Protection for Roses.* Central Expt. Farm Rept. 1899: 261.

BLAIR, WM., *Experiments with Bordeaux mixture as a preventive of Rot in Potatoes.* Central Expt. Farm Rept. 1900: 335.

BLAIR, WM., *Dusting vs Liquid Spraying.* Agr. Gaz. of Canada, Vol. 5, No. 3: 226, 1918. Results of spraying experiments, and comparison as to effectiveness and cost.

BRITTAIN, W. H., *Some Results from a few Combination Sprays.* Proc. Ent. Soc. of Nova Scotia 2: 9-12, 1916. Sprays for the control of insects(and diseases) of apples. Paul A. Murphy.

BRITTAIN, W. H., *Experimental Results in 1916.* Nova Scotia Fruit Growers' Association, Ann. Rept. 53: 68-78, 1917. Spraying for the control of insects (and diseases) of apples. Paul A. Murphy.

BRITTAIN, W. H., *Some Miscellaneous Results in 1917.* Nova Scotia Fruit Growers' Association, Ann. Rept. 54: 27-39, 1918. Spraying and dusting for the control of insects (and diseases) of apples. Paul A. Murphy.

BUSTIN, W., *The Potato Disease.* Nova Scotian Journal of Agriculture 1868.

CAESAR, L., *Little Peach Disease.* Ont. Agr. College Bul. 185: 1-8, 1910. Description of the symptoms of yellows and little peach and diseases likely to be confused with them. Recommendations for eradicating the diseases in question. R. E. Stone.

CAESAR, L., *Lime Sulphur Wash.* Ont. Agr. College Bul. 198: 1-44 (28 figs.), 1912. Preparation and use of lime sulphur; plant diseases that may be combatted with this fungicide; spray calendar. R. E. Stone.

CAESAR, L., *Some little known but Destructive Diseases Reported.* Ont. Agr. College and Expt. Farm, Ann. Rept. 38: 28, 1912. Raspberry yellow, a gooseberry disease, mosaic disease of tomato pine branch disease, also peach yellows and little peach. R. E. Stone.

CEASAR, L., *Pear Blight, Little Peach, Yellows, Apple Scab, Winter Injury.* Ont. Agr. College and Expt. Farm, Ann. Rept. 39: 29-31, 1913. Rept. on the occurrence and methods of control of the foregoing diseases. R. E. Stone.

CAESAR, L., *Pear Blight, testing new Spray Mixture, Peach, Yellows and little Peach.* Rept. of Ent. Dept., Ont. Agr. College and Expt. Farm, Ann. Rept. 42: 12-14, 1916. R. E. Stone.

CAESAR, L., *Dusting vs Spraying for the control of Fruit Trees, Insects and Plant Diseases.* Rept. of Ent. Dept., Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 20-21, 1917. Results on apple scab; results in other parts of the province; general discussion. R. E. Stone.

CAESAR, L., *Control of Brown Rot in Sweet Cherries; Pear Blight.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 21, 1917. R. E. Stone.

CLEMENT, F. M. and CAESAR, L., *Peach Growing (peach diseases).* Ont. Agr. College Bul. 201: 1-59 (19 figs.), 1912. Common peach diseases such as leaf curl, brown rot, scab, gum disease, powdery mildew, crown gall, yellows and little peach are discussed and remedies recommended. R. E. Stone.

CRAIG, JOHN, *Experiments with Fungicides.* Central Expt. Farm Rept. 1890: 95. Spraying for apple scab with copper carbonate, copper sulphate and sodium hypposulhite.

CRAIG, JOHN and SHUTT, F. T., *Effects of Fungicides on Apple Leaves.* Central Expt. Farm Rept. 1890: 97. Tabulated results of injury to apple foliage by use of various combinations of copper sulphate and copper carbonate, with and without ammonia.

CRAIG, JOHN, *Strawberies (winter injury).* Central Expt. Farm Rept. 1890: 78-79. 97 varieties placed in ten groups according to per cent of winter injury.

CRAIG, JOHN, *Injuries from Mice.* Central Expt. Farm Rept. 1891: 118. Preventives and remedial measures are given.

CRAIG, JOHN, *Apple Scab.* Central Expt. Farm Rept. 1891: 144. Spraying for apple scab with copper carbonate with and without ammonia.

CRAIG, JOHN, *Grape Mildew.* Central Expt. Farm Rept. 1891: 147.

CRAIG, JOHN, *Gooseberry Mildew.* Central Expt. Farm Rept. 1891: 147. Value in control of potassium sulphide, ammoniacal copper carbonate and copper carbonate are in the order named.

CRAIG, JOHN, *Treatment of Fungus Diseases.* Central Expt. Farm Rept. 1892: 97. Results of spraying on apple scab, gooseberry mildew, grape mildew and anthracnose of grape; record of *Cladosporium carpophilum* on native plums; notes on *Monilia fructigena* on plum and *Colletotrichum lindemuthianum* on beans. Experiments on treatment of bean seed for anthracnose by soaking in copper sulphate and ammoniacal copper carbonate; experiments on effect of adding lime to fungicides.

CRAIG, JOHN, *Pear and Apple Blight.* Central Expt. Farm Rept. 1893: 88. Tabulated nformation from 44 districts in Ontario and Quebec.

CRAIG, JOHN, *Effects of Dilute Sulphuric Acid on Foliage.* Central Expt. Farm Rept. 1893: 100. 4 strengths of ¼ to 1½% injured grape, plum, apple, rose, strawberry, geranium and hibiscus foliage.

CRAIG, JOHN, *Suggestions in Regard to Spraying for the Prevention of Fungus Diseases.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1893.

CRAIG, JOHN, *Effect of Winter 1890-94 on Standard Apple Orchard.* Central Expt. Farm Rept. 1894: 123. 124 varieties arranged in 4 groups according to the amount of injury.

CRAIG, JOHN, *Spraying Experiments.* Central Expt. Farm Rept. 1894: 108-121. Results o Bordeaux spraying on peaches, plums, cherries, pears and apple.

CRAIG, JOHN, *Lysol, a new Fungicide.* Central Expt. Farm Rept. 1895: 120. Tests for injury up to 4% strength. Used on peach for leaf curl.

CRAIG, JOHN, *Some Injurious Fungous Diseases.* Central Expt. Farm Rept. 1895: 122. Notes on *Sphaceloma ampelinum, Gloeosporium venetum, Cercospora violae,* and *Uromyces caryophyllinus.*

CRAIG, JOHN, Central Expt. Farm Bul. 23, 1895. Copper sulphate, ammoniacal copper carbonate and Bordeaux mixture are described, the diseases on fruit trees, where these are used are mentioned, and a spray calendar given. Potato blights are figured and described and Bordeaux mixture recommended. Black knot is also described and cutting out advised.

CRAIG, JOHN, *Raspberries.* Central Expt. Farm Bul. 22, 1895. In a short section on diseases, anthracnose aBd rust are dealt with.

CRAIG, JOHN, *Root Killing of Fruit Trees.* Central Expt. Farm Rept. 1896: 147. Note on the conditions favoring root injury by cold, with recomendations as to mulching, cover crops and hardy stocks. Survey of experimental farm orchards tabulating the extent and nature of the injury on cherries, plums and apples. Tentative grouping of peach and plum varieties with respect to hardiness of fruit buds.

CRAIG, JOHN, *Apple and Pear Blight.* Central Expt. Farm Rept. 1896: 168. Note on occurrence with tabular record of the yearly amount of blight in 142 varieties of Russian apples for three years (1893-1895).

CRAIG, JOHN, *A dry Rot of Apples.* Central Expt. Farm Rept. 1896: 171.

CRAIG, JOHN, *Core Rot of Apples and Pears.* Central Expt. Farm Rept. 1896: 172.

CRAIG, JOHN, *Spraying Experiments.* Central Expt. Farm Rept. 1897-105. Tests of lysol indicate little value. Formalin tested without injury to foliage but no useful results. Bordeaux used with good results.

CRAIG, JOHN, *Strawberries.* Central Expt. Farm Bul. 27, 1897. Leaf spot and mildew are mentioned.

CRAIG, JOHN, *Fungous Diseases.* Central Expt. Farm Rept. 1897: 110. Notes are given on apple scab, pear scab, peach mildew, shot hole on plum, gooseberry mildew and *Heterosporium gracile* on iris. A new trouble on peach somewhat resembling "rosette," and another on grapes, are mentioned. The results of treating seed potatoes for scab with lysol, corrosive sublimate, nitrate of soda, kainit and formalin indiacte that these are valuable in the order given.

CRAIG, JOHN, *Bean Anthracnose (soaking seed in various substancss to prevent anthracnose)*. Central Expt. Farm Rept. 1897: 120. Lysol, formalin, potassium sulphide, nitrate of soda, corrosive sublimate and kainit gave results in the order named of from 4 to 36% of diseased pods.

CUNNINGHAM, G. C., Rept. Lab. of Plant Pathology, Fredericton, N.B., Central Expt. Farm Rept. 1916: 1147-1149. Potato disease survey indicated 50% loss of crop by disease in 1915, black leg 7%, rhizoctonia 5%, mosaic 10%, late blight 25%. Notes are given on varied resistance to disease.

EASTHAM, J. W., *Slime Molds and their Economic Importance*. Quebec Soc. for Prot. Plants, Ann. Rept. 5: 66-71, 1916. A general discussion of slime molds and a description of species of economic importance in Canada; methods of control are also given. W. P. Fraser.

EASTHAM, J. W., *Diseases (and pests) of Cultivated Plants*. British Columbia Dept. of Agr. Bul. 68, 1916. Six pages of discussion of nature of diseases, their causes, and general methods of prevention, followed by the description of the most important plant diseases. Of interest among these is the occurrence of *Peronospora trifoliorum* Deby. on alfalfa in the dry belt.

FAIRCHILD, D. G., *The Toxicology of the Copper Compounds when applied as Fungicides*. Nova Scotia Fruit Growers' Association, Ann. Rept. 1892.

FLETCHER, JAMES, *Smuts affecting Wheat*. Central Expt. Farm Bul. 3, 1888. Hard smut and loose smut are described and remedies given.

FLETCHER, JAMES, *Black Knot of the Grape*. Central Expt. Farm Rept. 1889; 87. Notes the occurrence of stem malformations attributed to frost.

FLETCHER, JAMES, *Red Leaf or Blight of Oats*. Central Expt. Farm Rept. 1890: 178. Records occurrence and gives symptoms.

FLETCHER, JAMES, *Smut in Small Grain*. Central Expt. Farm Report. 1891: 206-207.

FLETCHER, JAMES, *Potato Blight and Potato Rot*. Central Expt. Farm Rept. 1892: 161-164.

FLETCHER, JAMES, *Blight on Oats and Barley*. Central Expt. Farm Rept. 1894: 186. Reddening of leaves associated with a bacillus.

FLETCHER, JAMES, *The Poplar Rust (Melampsora populina ,Jacq. Lev.)*. Central Expt. Farm Rept. 1901: 259-261.

FLETCHER, JAMES, *Maple Seed Blight*. Central Expt. Farm Rept. 1901: 259. A fungus, apparently a *Fusiraum* was found to be destructive of the ash-leaved maple (*Negundo aceroides* Muench), in Saskatchewan.

FLETCHER, JAMES, *The Rust of Grain Crops*. Central Expt. Farm Rept. 1904: 252. Account of the epidemic in western Canada in 1904 with popular account of the disease.

FLETCHER, JAMES, *Clover or Alfalfa Dodder*. Central Expt. Farm Rept. 1905: 201-204. Popular account of parasite with chemical analysis of affected and unaffected plants.

FLETCHER, JAMES, *A Northwest Tuckahoe*. Central Expt. Farm Rept. 1906: 232-5. Records the finding in the prairies of sclerotial masses said to be connected with *Polypori* (photo).

FRASER, W. P., *Rusts of Nova Scotia*. Proc. and Trans. Nova Scotian Institute of Science, 1909-10: 313-445, (24 figs.). Description of 92 species. Paul A. Murphy.

FULMER, H. L. and CAESAR, L., *Lime Sulphur Wash*. Ont. Agr. College Bul. 177: 1-63, (17 figs.), 1909. Study of the chemical composition of lime sulphur and arsenicals suitable for use with this fungicide; fungus diseases that may be combatted with lime sulphur. R. E. Stone.

GUSSOW, H. T., *A serious Potato Disease occurring in Newfoundland*. Central Expt. Farm Bul. 63, 1909. Describes the discovery of potato canker or wart disease due to (*Chrysophlyctis endobiotica* Schilb.), in Newfoundland. Describes the disease, recounts its history in Europe and warns against its introduction here.

GUSSOW, H. T., Rept. of Dom. Botanist, Central Expt. Farm Rept. 1910: 251-284 (2 pl. and 5 text figures). Rust in cereals and suggestions for prevention; early and late blight of potato, potato scab, and wet and dry rots; potato canker; apple scab; branch canker of fruit trees due to *Nectria distissima* Tub; coral spot fungus (*Nectria cinnabarina* Tode.); silver leaf; fire blight; crown gall; bacterial wilt of cucumbers and melons; powdery and downy mildews of grapes; white pine blister rust.

GUSSOW, H. T., Rept. of Dom. Botanist, Central Expt. Farm Rept. 1912: 193-209 (1 pl.). Under some diseases of cereals there are noted the findings of two *Helminthosporium* diseases of barley (*H. gramineum* and *H. satirum*). There are also recorded observations showing that frosted wheat produces plants which ripen unevenly. Under potato diseases are given the

following, warning against potato canker; corky scab; rhizoctonia. Other diseases dealt with are rot of turnips due to *Phoma napobrassicae* Rost., club root of crucifers; bitter pit of apples; shot hole of cherries; point rot of tomatoes; raspberry cane blight; blight of ginseng (*Alternaria panax*, Whetzel); leaf spot of iris (*Heterosporium gracile* Sacc); and leaf spot of rose (*Actinonema rosea* Lib. Fr.).

Gussow, H. T., *Potato Canker Imported into Canada.* Central Expt. Farm, Farmers' Cir. No. 1, 1912. Calls attention to this disease, notes its characters and destructive nature and warns against importation of European potatoes.

Gussow, H. T., Rept. of Dom. Botanist, Central Expt. Farm Rept. 1911: 237-260 4 pl., Rust, smut, and a mildew of wheat; frosted wheat; bacteria interfering with malting; apple diseases; frost belting of pears; bacterial blight of English walnut; diseases of small fruits; experiments in prevention of potato scab; internal spotting of potato tubers; onion mildew; alfalfa leaf spot; club root of crucifers; elm leaf spot, tar spot of maple, rose rust, and hollyhock rust.

Gussow, H. T., Rept. of Dom. Botanist, Central Expt. Farm Rept. 1913: 477-498. General discussion of question of storage rots of potatoes; from experiments on potato rhizoctonia, including liming the soil, treatment of seed with corrosive sublimate, sulphur and lime sulphur, the conclusion was drawn that no constant differences could be seen from these treatments; of several methods tried out for scab on potatoes, sawdust had little effect, lime sulphur reduced the disease but gave lower yield, and chloride of lime was markedly injurious. The ergot fungus is described; a short summary of McAlpine's investigations in bitter pit is given, and an account of investigation of a storage spot of apples is recorded, the cause not being definitely ascertained.

Gussow, H. T., *Smut Diseases of Cultivated Plants and their cause and control.* Central Expt. Farm Bul. 73, 1913. Discussion of the various smuts, their life histories, and the methods of control.

Gussow, H. T., Rept. of Dom. Botanist, Central Expt. Farm Rept. 1914: 834-838 (1 pl.). Of potato diseases, the organism causing common scab is referred to the genus *Actinomyces*, a note is given on silver scurf, and a black heart is shown to be due to low temperature. In regard to fruit diseases a note on *Nectria* canker on apples in eastern Canada is given, and another pointing out a type of silver leaf in British Columbia due to a mite which might be mistaken for that produced by *Stereum purpureum.*

Gussow, H. T., *Powdery Scab of Potatoes.* Agr. Gaz. of Canada, Vol. 1, No. 2: 125, 1914. Discusses the United States embargo as it is likely to affect Canadian potato growers. Gives illustrations and description of the disease, notes its occurrence, and outlines means of control.

Gussow, H. T., International Phytopathological conference at Rome. Agr. Gaz. of Canada, Vol. 1, No. 5; 340, 1914.

Gussow, H. T., *The American Potato Embargo and its removal from the Dominion of Canada.* Agr. Gaz. of Canada, Vol. 1, No. 12: 954, 1914.

Gussow, H. T., Rept. of Dom. Botanist, Central Expt. Farm Rept. 1915: 951-989. Notes on potato inspection in 1914: losses from improper storage placed at about seventeen per cent prevalance of minor diseases, raising of U. S. embargo for powdery scab. Potato diseases; experiments on the effects of pig, cow, horse, sheep and hen manure on potato ; scab indicated that horse manure increased the amount more than the others while sheep and hen manure gave a crop with least scab; bichloride of mercury is recommended as a seed treatment for *Rhizoctonia* mention is made of powdery scab, net necrosis, silver scurf, blackleg, leaf roll and mosaic.; General account of clover and alfalfa wilt diseases due to *Sclerotinia ciborioides* (*S. trifoliorum*).

Gussow, H. T., *The Control of Potato Diseases.* Agr. Gaz. of Canada, Vol. 2, No. 4: 323, 1915

Gussow, H. T., *Potato Inspection in Practice.* Agr. Gaz. of Canada, Vol. 2, No. 5: 415, 1915.

Gussow, H. T., *Effect of wet season on Wheat.* Agr. Gaz. of Canada, Vol. 2, No. 10: 932, 1915. Notes on the occurrence of "sooty ear" of wheat, glume spot of wheat and wheat scab.

Gussow, H. T., *Repeal of the Powdery Scab Regulations.* Agr. Gaz. of Canada, Vol. 2, No. 11: 1048, 1915.

Gussow, H. T., *Grain Rust in the Prairie Provinces.* Agr. Gaz. of Canada, Vol. 3, No.10: 861, 1916. Outline of the general situation in regard to grain rust with recommendations concerning future means of elimination.

Gussow, H. T., *Plant Diseases vs National Wealth.* Agr. Gaz. of Canada, Vol. 3, No. 3: 211, 1916.

Gussow, H. T., Rept. of Division of Botany, Central Expt. Farm Rept. 1916: 1097-1127, (7 pl.). White pine blister rust; the present Canadian situation is outlined and an account given of the work of the year on this disease. Powdery scab of potatoes; experiments are recorded showing that corrosive sublimate is the best seed disinfectant, with formalin second; keeping the seed in a warm room just before planting doubled the amount of scab. Notes on the improvement of the potato crop, recommending field and crop inspection; potato spraying experiments. Three grain troubles are noted, "sooty ear" of wheat, referred to *Cladosporium*, glume spot of wheat due to *Septoria Glumarum* Pass. and wheat scab. A note on bitter pit or fruit pit of apples summarizes McAlpine's investigations.

Harcourt, R. and Fulmer, H. L., *Insecticides and Fungicides.* Ont. Agr. College Bul. 154: 1-32, 1907. Description of preparation and chemical composition of the common insecticides and fungicides. R. E. Stone.

Harcourt, R. and Fulmer, H. L., *Insecticides and Fungicides.* Ont. Agr. College Bul. 195, 1912. Study of chemical composition and, preparation of common insecticides and fungicides. R. E. Stone.

Harrison, F.C. and Barlow, B., *Some Bacterial Diseases of Plants prevalent in Ontario.* Ont. Agr. College Bul. 136: 1-33 (12 figs.), 1904. Discusses fire blight or twig blight, bacteriosis of beans, soft rot of cauliflowers, fall turnip, etc., soft rot of swedes or yellow turnips, soft rot of celery. R. E. Stone.

Harrison, F. C., *A Bacterial Disease of Cauliflower (Brassica oleracea), and allied plants.* Ont. Agr. College Bul. 187: 1-32 (12 figs.), 1904. A careful study of the causaul organism (*Bacillus olearaceae* n. sp.), isolation, cultural characters, histology of diseased plants and chemical products of the causal organism. R. E. Stone.

Harrison, F. C. and Sadler, Wilfrid, *A Bacterial Soft Rot of Turnips.* Trans. Royal Society of Canada (Third Series), Vol. 7, part 4: 91-106 (figs. 1-14), 1913. Pethogenicity of an organism belonging to the "soft rot" type is worked out in detail. Morphological and cultural features described. W. P. Fraser.

Harrison, F. C. and Sadler, Wilfrid, *A Bacterial Soft Rot of Turnips.* Quebec Soc. Prot. Plants, Ann. Rept. 6: 59-72 (figs. 1-15), 1914. The pathogenicity of an organism of the "soft rot" type which was the cause of a rotting disease in turnips is described in detail. Morphological and cultural features of the organism are described and field notes on the disease are given. W. P. Fraser.

Howitt, J. E., *Fungus Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 38: 29-32. List of the common fungus diseases of the year. Ginseng diseases with measures of control. R. E. Stone.

Howitt, J. E., *Fungus Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 37: 47-51, 1911. Report on common fungus diseases with special reference to loose smut of wheat, hollyhock rust, crown rust of oats, rose leaf blotch, blight of ginseng, sooty blotch of apple. R. E. Stone.

Howitt, J. E., *Fungi and Plant Pathology.* Ont. Agr. College and Expt. Farm Ann. Rept. 39: 35-49, 1913. List of diseases attracting most attention during the year. Plant diseases comparatively new in Ontario, club root of cabbage, powdery scab of potatoes, raspberry yellows and cane blight. Experiments in the control of late blight of celery, with Bordeaux mixture recommended. Notes on the apothecial stage of *Sclerotinia cinerea* in Ontario. R. E. Stone.

Howitt, J. E., Rept. of Botanist, Ont. Agr. College and Expt. Farm, Ann. Rept. 41: 17-22, 1915. Experiments to control late blight of celery. Spraying experiments to prevent rose-leaf blotch. White pine blister rust (*Peridermium strobi*), its occurrence in Ontario. A troublesome disease of winter tomatoes. R. E. Stone.

Howitt, J. E. and Stone, R. E., *The Smuts and Rusts of Grain Crops.* Ont. Agr. College Bul. 229: 1-24 (15 figs.), 1915. Discussion of the smuts and rusts of wheat, oats, barley and corn, estimates of the annual losses due to these diseases. Description of the different smuts with life history of the causal organism and methods of prevention. Formalin treatment recommended where possible. Description of some grain rusts and their life histories where known, recommendation of destruction of barberry and buckthorn, methods of culture, varieties suitable to Ontario; citation of law for the destruction of the barberry.

Howitt, J. E., Rept. Dept. of Botany, Ont. Agr. College and Expt. Farm, Ann. Rept. 42: 15-18, 1916. Fungus diseases; diseases new in Ontario; inspection for white pine blister rust. R. E. Stone.

HOWITT, J. E., *Fungus Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 25, 1917. Discussion of prominent fungus diseases of the year, with special reference to late blight and rot of potatoes. R. E. Stone.

HOWITT, J. E., *Potato Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 25, 1917. Discussion of occurrence, symptoms and control of leaf roll, mossaic, and curly dwarf. R. E. Stone.

HOWITT, J. E., *Experiments to control Late Blight of Celery.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 28, 1917. Resume of results of five years' spraying experiments. Bordeaux mixture recommended. R. E. Stone.

HOWITT, J. E., *Experiments in Sprinkling Seed Oats with Formalin for Prevention of Smut.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 29, 1917. Directions for sprinkling and precautions to be taken. R. E. Stone.

HOWITT, J. E. and JONES, D. H., *The more important Fungus and Bacterial Diseases of Vegetables in Ontario.* Ont. Agr. College Bul. 258: 1-48 (29 figs.), 1918. Description of the fungus and bacterial diseases of vegetables with causal organisms, modes of infection, remedies. R. E. Stone.

JACKSON, V. W., *Potato Diseases in Manitoba.* Man. Extension Bul. No. 14, 1917.

JACKSON, V. W., *Where is Wheat Rust now? Farmers' Advocate (Winnipeg, Man.), Dec. 5, 1918: 1886.* Discusses the part played by wild barley (*Hordeum jubatum*) in the over wintering of grain rust, and gives results of observations showing that germinable uredospores occurred on this host on Nov. 15th after twenty-five frosts.

JACKSON, V. W., *Rusts in General.* Farmers' Advocate (Winnipeg, Man.), Dec. 18, 1918: 2028. Popular article on rusts giving alternate hosts of twenty rusts.

JACKSON, V. W., *Potato Diseases in Manitoba.* Manitoba Horticulturist, No. 1918: 78. Common diseases (with six illustrations) described and methods of control given.

JONES, D. H., *Bacterial Blight of Apple, Pear and Quince Trees.* Ont. Agr. College Bul. 176: 1-63 (58 figs.), 1909. Careful study of bacterial blight of pomaceous fruits. The causal organism, effect on the host, dissemination of the bacillus, inoculation, eradication and prevention of the disease. R. E. Stone.

JONES, D. H., *Some Bacterial Diseases of Vegetables found in Ontario.* Ont. Agr. College Bul. 240: 1-24 (10 pl.), 1916. Description of vegetable diseases due to bacteria, giving symptoms, causal organism, mode of infection and remedies, for soft rot of vegetables, blackleg of potatoes, bacteriosis of bean, bacterial wilt of crucifers, bacterial wilt of cucumbers. R. E. Stone.

KLEE, W. G., *Pear and Apple Scab Blight.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1888.

KLINCK, L. S., *The susceptibility of certain Cereals to Smut.* Quebec Soc. for the Prot. Plants, Ann. Rept. 2: 14-15, 1910. Describes the results of observations on the prevalence of smut in experimental plots, and states the factors which these observations show play an important part in determining the amount of smut. W. P. Fraser.

LAWSON, GEO., *Blights and Diseases of Plants.* Nova Scotian Journal of Agriculture 1866. Diseases due to physiological disturbances accompanied frequently by lowly organisms. Paul A. Murphy.

LAWSON, GEO., *The Potato Disease.* Nova Scotian Journal of Agriculture 1884. Description of *Peronospora infestans.* Paul A. Murphy.

LLOYD, F. E., *Injury and Abscission in Impatiens sultani.* Quebec Soc. for the Prot. Plants, Ann. Rept. 6: 72-79, 1913-14.

LOCHHEAD, WM. and JARVIS, T. D., *The Common Fungus and Insect Pests of Growing Vegetable Crops.* Ont. Agr. College Bul. 100: 1-34. Describes and figures common diseases and insect pests of vegetables arranged under hosts. Gives remedies in each case. Preparation of fungicides and insecticides. R. E. Stone.

LOCHHEAD, WM., *Apple Scab, Peach Leaf Curl.* Ont. Agr. College and Expt. Farm, Ann. Rept. 24: 14-18, 1998.

LOCHHEAD, WM., Ont. Agr. College and Expt. Farm, Ann. Rept. 26: 16-20, 1900. Celery blight (*Cercospora apii*); asparagus rust; bluestone to prevent oat smut; new disease of balsams (*Trimmatostroma abietina*). R. E. Stone.

LOCHHEAD, WM., *Injurious Insects and Fungus Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 27, Vol. 1: 18: 25 (7 figs.), 1901. Discussion of *Puccinia graminis* and *Laestadia bidwellii.* R. E. Stone.

LOCHHEAD, WM., *Spray Calendar and Directions for Treatment of Insect Pests and Plant Diseases.* Ont. Agr. College Bul. 122: 1-12, 1902. Directions for the preparation and use of the common fungicides and insecticides. R. E. Stone.

LOCHHEAD, WM., *Some Injurious Insects and Fungus Diseases of the year 1902.* Ont. Agr. College and Expt. Farm, Ann. Rept. 28: 19-28 (10 figs.), 1902. Tobacco leaf spot, beet leaf spot, leaf spot of horse chestnut, shot hole of plum and cherry, anthracnose of bean, apple scab, pear scab, sooty blotch of apple, brown rot of stone fruits, with remedies. R. E. Stone.

LOCHHEAD, WM., *Egyptian Pea Blight, the Raspberry Cane Blight, the Two potato Blights.* Ont. Agr. College and Expt. Farm, Ann. Rept. 29: 26-32 (figs. 6-12), 1903. Egyptian pea blight (*Ascochyta pisi*), raspberry cane blight (*Coniothyrium*) treatment recommended. Potato blights; distinction between the two, and methods of treatment. R. E. Stone.

LOCHHEAD, WM., *Insects and Fungous Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 30: 40-49, 1904. A key to the fungus diseases of the apple, also keys to the fungus diseases of the peach, brambles, grosselles and the grape; these keys based on part of the plant affected and the gross character of the lesions. Apple tree cankers, sunscald, nectria canker, bitter rot and black rot are also discussed. R. E. Stone.

LOCHHEAD, WM., *Some Fungus troubles of the year.* Ont. Agr. College and Expt. Farm, Ann. Rept. 31: 52-58, 1905. Melon blight (*Plasmopara cubensis*) strawberry root blackening, grape leaf mosaic, leaf spot of violets, leaf spot of apple, fly speck, black mold of onions, brown rot of plums, late blight of potato, injurious action of Bordeaux in apple orchards. R. E. Stone.

LOCHHEAD, WM., *A Stem Rot Disease of Potatoes.* (*Corticium vagum* B. & C. var. *Solani* Burt.). Quebec Soc. Prot. Plants, Ann. Rept. 2: 32-35 (figs. 1-4), 1910. The stems are attacked below ground, the bark destroyed and stem girdled. Affected plants are dark green and unthrifty. No other fungus seemed present Disease winters as sclerotia and attacks tubers when planted. Treatment as for scab. P. I. Bryce.

LOCHHEAD, WM., *Three Important Fungous Diseases of the Orchard.* (Apple Scab, Black Rot, and Brown Rot). A popular description. Que. Soc. Prot. Plants. Rep. 1: 53-59 (Fig. 15-19) 1909. Some *Fungous Diseases of the Garden.* (Orange Rust, Downy Mildew of Melon, and Club Root of Cabbage). Rep. 1: 73-75 (Fig. 20) 1909.

LOCHHEAD, WM., *Four Common Fungous Diseases of the Garden.* (Gooseberry Mildew, Currant Anthracnose, Raspberry Anthracnose and Strawberry Leaf Spot). A popular account. Que. Soc. Prot. of Plants. Rep. 2: 20-25, 1910. *Some Fungous Diseases of the Greenhouse.* (Carnation Rust, Damping-off and Drop of Lettuce). A popular description. Que. Soc. Prot. Plants, Rep. 2: 70-72, 1910.

The Crown Gall of Fruit Trees. Que. Soc. Prot. Plants Rep. 2: 76-78, 1910.

LOCHHEAD, WM., *Some Fungous Diseases of Field Crops.* (Smuts and Rusts). Que. Soc Prot. Plants, Rep. 3: 67-77, 1911.

LOCHHEAD, WM., *Apple Tree Cankers.* Que. Soc. Prot. Plants, Rep. 4: 39-43, 1912.

MACKAY, ANGUS, *Experiments on Wheat and Oat Smut.* Central Expt. Farm Repts. 1892: 227, 228, 233, 1893: 278, 1894: 345, 338; 1896: 380, 386, 389; 1897: 362, 365; 1898: 332, 336; 1899: 135.

MACKAY, ANGUS, *Tests of Preventives of Smut in Wheat, Oats and Barley.* Central Expt. Farm Repts. 1899: 342, 345, 348; 1900: 394, 397, 399; 1901: 468, 461, 465.

MACKAY, ANGUS, *Bluestone as a Smut Preventive.* Central Expt. Farm Repts. 1903: 362; 1904: 422, 424, 416, 419; 1905: 324; 1906: 347, 348.

MACOUN, W. T., *Dry Rot, Brown Spot, or Baldwin Spot of the Apple.* Central Expt. Farm Rept. 1899: 96.

MACOUN, W. T., *Experiments in Whitewashing Trees.* Central Expt. Farm Rept. 1899: 92-94. Whitewash was applied to apple, plum and cherry trees to retard bud swelling in spring. Marked retardation resulted in the swelling of plum and cherry, but there was little effect on apple buds.

MACOUN, W. T., *Asparagus Rust.* Central Expt. Farm Rept. 1901:110. Popular description with favorable results from experimental spraying with Bordeaux and resin sticker.

MACOUN, W. T., *Apple culture.* Central Expt. Farm Bul. 37, 1901. A section on diseases deals with fire blight, scab, crown gall, dry rot, sunscald, mice, bitter rot, sooty blotch, dropping of leaves and spraying injury.

MACOUN, W. T., *Rept. of Dom. Horticulturist.* Central Expt. Farm Rept. 1902:110-120. Notes on the occurrence of sooty blotch of apple (*Leptothyrium pomi*), russetting of apples, dropping of apple leaves, and black rot of cabbage. Comparison of the use of bug death and Bordeaux as a potato spray is in favor of the latter.

MACOUN, W. T., *Diseases of Fruits.* Central Expt. Farm Rept. 1903: 106. Mention is made of apple spot (scab), brown rot (*Sclerotinia*), peach leaf curl and black rot of the grape.

MACOUN, W. T., *Winter Killing of Apple Trees.* Central Expt. Farm Rept. 1904:109-111. 90 varieties top grafted on hardy stocks were badly killed in winter of 1903-04. A table is given of 164 winter killed varieties including the above.

MACOUN, W. T., *Fungous Diseases of the Grape.* Central Expt. Farm Rept. 1904: 123. Popular description of ordinary grape diseases, and notes on their occurrence are given.

MACOUN, W. T., *Spraying Potatoes for the Prevention of Blight and Rot.* Central Expt. Farm Rept. 1904: 131-132. Results with Bordeaux, with poison added, are given for fifteen varieties.

MACOUN, W. T., *Fungous Diseases.* Central Expt. Farm Rept. 1905: 111-121. Notes on brown rot of plum and black rot of grape; preparation of Burgundy mixture; potato varieties resistant to blight; results of potato spraying.

MACOUN, W. T., *The Potato and its Culture.* Central Expt. Farm Bul. 49, 1905. Early and late blight, tip burn, and scab are discussed and figures are given on the cost of spraying and three years' results.

MACOUN, W. T., *Fungous Diseases.* Central Expt. Farm Rept. 1906: 121. Notes on pear blight (*B. amylovorus*), sooty or fly speck fungus of apple, black rot of the tomato, onion blight (*Peronospora*). Table of potato varieties resistant to rot and blight.

MACOUN, W. T., *Bush Fruits.* Central Expt. Farm Bul. 56, 1907. The ordinary diseases and methods of control are included.

MACOUN, W. T., *Dry Rot of Apple (Baldwin spot).* Central Expt. Farm Rept. 1908: 128.

MACOUN, W. T., *Winter Injury to Fruit Trees.* Central Expt. Farm Rept. 1908: 110. Ten ways in which trees are affected by winter are discussed.

MACOUN, W. T., *Potato Varieties Resistant to Blight and Rot.* Central Expt. Farm Rept. 1908: 126.

MACOUN, W. T., *The Flax Plant.* Central Expt. Farm Bul. 59, 1908. Mention is made of flax "wilt."

MACOUN, W. T., *Rept. of Dom. Horticulturist.* Central Expt. Farm Rept. 1909: 126-127. Of the diseases of native plums (*Prunus nigra*) there are mentioned spot or blight (*Cladosporium carpophilum* Thum), and plum pockets (*Exoascus Pruni* Fckl.).

MACOUN, W. T., *Strawberry Culture.* Central Expt. Farm Bul. 62, 1909. Leaf spot and mildew dealt with as the two outstanding diseases.

MACOUN, W. T., *Results in Horticulture.* Central Expt. Farm Bul. 82, 1915. Results are given showing the value of the dormant spray in apple scab control. Other results serve to compare lime sulphur and Bordeaux for apple scab and these two fungicides for their russetting effect. Further experiments indicate that sugar added to Bordeaux will not prevent russetting.

MACOUN, W. T., *The Apple in Canada.* Central Expt. Farm Bul. 86, 1916. There are here discussed various kinds of frost injury including root killing, bark splitting, trunk splitting, sun-cald, trunk or body injury, crotch injury, killing back, black-heart, discoloration of sapwood, killing of dormant buds and killing of swollen buds. There are also remarks on frost injury to flowers and fruit, dropping of apple leaves, russetting of fruit and water core.

MCCREADY, S. B., *Injurious Fungus Diseases of the year 1907.* Ont. Agr. College and Expt. Farm, Ann. Rept. 33: 48-49, 1907. Crown gall, pear leaf scald, *Alternaria* blight of ginseng, blighting of oats. Causal organism noted, remedies suggested. R. E. Stone.

MCCREADY, S. B., *Plant Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 34: 41, 1908. A few common plant diseases listed. R. E. Stone.

MCCREADY, S. B., *Plant Diseases.* Ont. Agr. College and Expt. Farm, Ann. Rept. 35: 40-41, 1909. Some common plant diseases listed. Report of work by A. Eastham on black rot canker (*Sphaeropsis malorum*). R. E. Stone.

MCCUBBIN, W. A., *The St. Catharines Field Laboratory of Plant Pathology.* Agr. Gaz. of Canada, Vol. 1, No. 8: 612, 1914.

McCUBBIN, W. A., *Report of the St. Catharines Field Laboratory.* Central Expt. Farm Rept. 1914: 845-849. Notes on general conditions in 1913 are given, with observations on fruit diseases occurring in the Niagara Peninsula.

McCUBBIN, W. A., *Fruit Tree Diseases of Southern Ontario.* Central Expt. Farm Bul. 24, (Second Series), 1915. The ordinary diseases of tree fruits are discussed and methods for control are given.

McCUBBIN, W. A., *The Wilting of Tomatoes and Potatoes.* Agr. Gaz. of Canada, Vol. 2. No. 9: 831, 1915. Wilt due to rotting of roots in waterlogged soil.

McCUBBIN, W. A., *Report of the St. Catharines Field Laboratory.* Central Expt. Farm Rept. 1915: 966-988 (7 pl.). Notes on various diseases; irregular apples; blighting of cherry shoots; *Fomes applanatus* on cherry trunks ; winter injury on cherry trunks; dropping of currant canes; the currant *Polyporus* (*Pyropolyporus ribis* Schum.) Murrill, chlorosis of grapes; *Gloesporium* on oak leaves; oleander leaf spot: *Botrytis* rot of onions in storage; brown rot (apothocial stage notes on occurrence of; injury from cannery refuse; peach canker germination of peach pits from yellow trees; winter injury to peach buds; pear blight epidemic; sunburn on pear foliage; sunscald of Omaha plums; raspberry cane blight; *Botrytis* rot of strawberries; mosaic disease of tomatoes; spotted tomatoes.

McCUBBIN, W. A., *The White Pine Blister Rust in Canada.* Quebec Soc. for the Prot. of Plants, Ann. Rept. 8: 64, 1916. Address given to the Society covering nature and dangerous features of the disease in a popular way.

McCUBBIN, W. A., *Report of the St. Catharines Field Laboratory.* Central Expt. Farm Rept. 1916: 1134-1144. Squirrel scars on maple limbs; defoliation of sycamore; cherry fruit spot due to frost; cherries injured by wet soil; winter killing of strawberry roots; strawberry mildew; a ripe rot of pears and peaches due to *Rhizopus nigricans;* heart rot of peach trees; purple spotting of raspberry canes (*Sphaerella rubina*); mosaic disease of tomato; a survey gives 40% of field affected with 3.43% of plants diseased; conditions found indicate lowering of yield and seed bed infection.

McCUBBIN, W. A., *Peach Canker.* Central Expt. Farm Bul. 37 (Second Series), 1918. The cause of the disease is attributed to the fungus *Valsa leucostoma* (Pers.) Fr. which enters by way of dead twigs, pruning wounds, and other dead tissue, and invades the surrounding live tissue particularly in winter. Injury from frost is also thought to play a part in the extension of the canker, and the part played by *Sclerotinia cinerea* in canker production is discussed. Control measures recommended involve pruning methods for the most part.

McCUBBIN, W. A., *Tomato Diseases.* Central Expt. Farm Bul. 35 (Second Series), 1918. Diseases common on tomatoes in Southern Ontario are described and control methods given. A key based on readily recognized features is supplied.

McCUBBIN, W. A., *The White Pine Blister Rust situation.* Agr. Gaz. of Canada, Vol. 5, No. 4: 339, 1918. Report of the general results of work in Canada in 1917.

McGILL, GEO. B., *Diseases of Agricultural Plants.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1887. *Peronospora infestans; Sphaeria morbosa;* mildews of grape vine; use of fungicides Paul A. Murphy.

MILLER, JUSTUS, *Specialists meet to discuss the Potato situation.* Agr. Gaz. of Canada, Vol. 4, No. 12: 1061, 1917. Account of a conference to revive the potato industry in Ontario mainly by elimination of diseases.

MOORE, CLARENCE L., *Myxomycetes of Pictou County.* Proc. and Trans. Nova Scotia Institute of Science 1907-8. Includes *Plasmodiophora brassicae.* Paul A. Murphy.

MURPHY, PAUL A., *Report of Field Laboratory of Plant Pathology, Charlottetown, P.E.I.* Central Expt. Farm Rept. 1916: 1144-1147. Mussel mud as lime for treatment of club root in crucifers; scheme for improvement of the "Garnet Chili" seed potato industry in Nova Scotia.

MURPHY, PAUL A., *Apple Dusting in Nova Scotia.* Nova Scotia Fruit Growers' Association, Ann. Rept. 53: 44-50, 1917. Comparison of disease control by dusting and spraying. Paul A. Murphy.

MURPHY, PAUL A., *Apple Dusting in Nova Scotia.* Agr. Gaz. of Canada, Vol. 4, No. 4: 254, 1917. Favorable results were obtained from the two orchards dusted in 1916.

MURPHY, PAUL A., *The Mosaic Disease of Potatoes.* Agr. Gaz. of Canada, Vol. 4, No. 5; 345, 1917. Popular account of the disease, giving table of the yields from 11 healthy and diseased plots. The yield of the diseased plots average 57.8% of that from the healthy.

MURPHY, PAUL A., *Prevention of Field and Storage Rot of Potatoes by Bordeaux Mixture.* Agr. Gaz. of Canada, Vol. 4, No. 11: 942, 1917.

MURPHY, PAUL A., *Comparison of Dusting and Spraying Apples in Nova Scotia in 1917.* Nova Scotia Fruit Growers' Association, Ann. Rept. 54: 58-71, 1918.

PANTON, J. HOYES, *Rust* (*Puccinia graminis*). Ont. Agr. College Bul. 36: 1-16, 1888. Discusses life history of the fungus. Discusses methods of control of the rust disease, such as avoidance of too much nitrogenous fertilizer, avoidance of the barberry, sowing of red in place of white wheats, early sowing, avoidance of low ground. R. E. Stone.

PANTON, J. HOYES, *Black Knot on Plums.* Ont. Agr. College Bul. 52: 1-5, 1890. Describes life history and morphology of the black knot fungus. Remedies suggested, destruction of affected limbs and trees, application of linseed oil to the knots, use of coil oil and destruction of choke cherry trees in the vicinity of the orchard. R. E. Stone.

PANTON, J. HOYES, *Smut, its Habits and Remedies.* Ont. Agr. College Bul. 56: 1-6, 1890. *Tilletia caries* (bunt or stinking smut), *Ustilago carbo* (common or loose smut), *Ustilago zea-mays* (corn smut). Life histories of the fungi are discussed. Seedling infection by bunt recognized; same life history suggested for loose smut. Remedies,—sow clean seed, steep seed in copper sulphate, 1 lb. to 1 gal. water, five minutes; or 1 lb. to 40 gallons water, 24 hours steep. Caustic potash 1 lb. to 6 gal. water, very strong brine. Hot water 135°F. for five minutes or 132° for 15 minutes. R. E. Stone.

PANTON, J. HOYES, *Black Knot on Plums.* Rept. Ont. Dept. of Agr., Ont. Agr. College Rept. 16: 39, 1890.

PANTON, J. HOYES, *Fungicides and Insecticides.* Ont. Agr. College Bul. 73: 1-6, 1892. Describes the preparation of Bordeaux mixture, Eau celeste, Eau grison, copper sulphate,ammoniacal solution of copper carbonate, potassium sulphide, sodium hyposulphate. R. E. Stone.

PANTON, J. HOYES, *Insecticides and Fungicides.* Ont. Agr. College and Expt. Farm, Ann. Rept. 18: 1892. Cites Bul. 73. R. E. Stone.

PANTON, J. HOYES, *Remedies for Common Plant and Insect Foes.* Ont. Agr. College Bul. 87: 1-8, 1893. Describes preparation of common fungicides and insecticides. Enumerates ten of the common fungus diseases and recommends treatment. R. E. Stone.

PANTON, J. HOYES, *Raspberry Anthracnose, Grape Diseases, how to prevent Smut.* Ont. Agr. College and Expt. Farm, Ann. Rept. 20: 7-18, 1895, part II.

PANTON, J. HOYES, *Spray Calendar.* Ont. Agr. College and Expt. Farm, Ann. Rept. 21: 9-12, 1896.

PANTON, J. HOYES, *Instructions on Spraying.* Ont. Agr. College Bul. 105: 1-6, 1897. Describes preparation of Bordeaux mixture and ammoniacal copper carbonate solution. Recommends sprays for apple, pear, plum, peach, cherry, grape, raspberry, currant and gooseberry, tomato, potato, cabbage, strawberry. Enumerates injurious insects and fungi. R. E. Stone.

PANTON, J. HOYES, *Diseases Affecting the Grape.* Ont. Agr. College Bul. 92: 1-8. Discusses downy mildew (*Peronospora viticola*), black rot (*Laestadia bidwellii*) powdery mildew (*Uncinula spiralis*) anthracnose (*Sphaceloma ampelinum*). Discusses also remedies. R. E. Stone.

PENHALLOW, D. P., *The Spot Disease of the Fameuse.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1887. *Fusicladium dendriticum.* Paul A. Murphy.

ROY, HENRI, *The White Pine Blister Rust situation in Quebec.* Quebec Soc. Prot. of Plants, Ann. Rept. 10: 25-30, 1918. W. P. Fraser.

SANDERS, G. E., *The Effect of Certain Combinations of Spraying Materials on the set of Apples.* Proc. Ent. Society of Nova Scotia 2: 17-21, 1916.

SANDERS, G. E. and KELSALL, A., *The Dropping of Apples caused by Spraying with Lime Sulphur.* Proc. Ent. Society of Nova Scotia 3: 76-83, 1917.

SANDERS, G. E., *Some Results from Spraying Work in 1916.* Nova Scotia Fruit Growers, Association, Ann. Rept. 53: 160-177, 1917. Spraying for the control of insects (and diseases) of apples. Paul A. Murphy.

SANDERS, G. E., *Apple Spraying.* Nova Scotia Fruit Growers' Association, Ann. Rept. 54: 72-92, 1918. Spraying for the control of insects (and diseases) of apples. Paul A. Murphy.

SAUNDERS, WM., *Smut in Wheat.* Central Expt. Farm Rept. 1893: 41-42.

SAUNDERS, WM., *Tests for the Prevention of Smut in Oats.* Central Expt. Farm Rept. 1896; 12; 1897: 8.

SAUNDERS, WM., *Formalin and Massel Powder as Preventives of Smut in Oats and Barley.* Central Expt. Farm Rept. 1900: 12.

SHUTT, F. T., *Experiments on the Prevention of Hard Smut or Bunt in Wheat.* Central Expt. Farm Rept. 1890: 146; 1891: 183-185. Mainly tests of the effect of copper and iron sulphate on the vitality of the seed.

SHUTT, F. T., *Experiments on the Prevention of Smut in Wheat.* Central Expt. Farm Rept. 1892: 137.

SHUTT, F. T., *Soda Bordeaux or Burgundy Mixture.* Central Expt. Farm Rept. 1905: 149.

SHUTT, F. T., *Formaldehyde as a Smut Preventive.* Central Expt. Farm Rept. 1905: 151-153. Analyses of commercial solutions are given; the action on seed vitality tested; and milky (*polymerized*) formaldehyde is tested as a smut preventive.

SHUTT, F. T., *Insecticides and Fungicides.* Central Expt. Farm Rept. 1903: 165-173. Analysis of commercial formaldehydes; effect of exposure on formaldehyde solutions is to increase the concentration. Tests of bluestone and formaldehyde on seed vitality. Lime sulphur washes; analysis of V 1 and V 2 Vaporite and "anti-fungi."

SEARS, F. C., *Spraying; its Past, Present and Future.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1898.

SEARS, F. C., *Some Recent Developments in Spraying.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1899.

SEARS, F. C., *Collar Rot of Apple Trees.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1901. Two types-one due to winter killing, the other due to fungi. Paul A. Murphy.

SHARPE, T. A., *Spraying with Bordeaux for Potato Blight.* Central Expt. Farm Rept. 1892: 272. Tables of tests on 22 varieties sprayed twice give somewhat irregular results.

SHARPE, T. A., *Tests of Formalin and Massel Powder as a Preventive of Smut in Barley and Oats.* Central Expt. Farm Rept. 1899: 394; 1900: 454:5.

STONE, R. E., *Experiments on the cause and means of Control of a Peculiar Disease of winter Tomatoes.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 30, 1917. Winter Blight. Results of three years work give promise of control by means of acid phosphate as a fertilizer. R. E. Stone.

STONE, R. E., *Investigations on the Extent late Blight of Celery is carried over in Seed.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 30, 1917. No diseased seedlings from more than 3,000 seeds. R. E. Stone.

STONE, R. E., *Control of Snapdragon Rust.* Ont. Agr. College and Expt. Farm, Ann. Rept. 43: 30, 1917. Diagnosis of the disease, its occurrence, importation, and means of control. R. E. Stone.

SMITH, H. W., *Some Plant Diseases in Nova Scotia.* Nova Scotia Fruit Growers' Association, Ann. Rept. 1910. Silver leaf recorded on Blenheim apple. Paul A. Murphy.

WHETZEL, H. H., *A Parasitic Fungus that Winters in the Seed of its Host.* Ont. Natural Science Bul. 4: 7-9, 1908 (4 figs.). A short account of *Colletotrichum lindemuthianum* in bean seed. R. E. Stone.

WHETZEL, H. H., *A Fungus living as a Parasite on another Fungus.* Ont. Natural Science Bul. 5: 1-4, 1909 (2 figs.). Account of *Cephalothecium roseum* on *Scleroderma vulgare.* R. E. Stone.

WHETZEL, H. H., *Ginseng and its Diseases.* Ont. Natural Science Bul. 7: 22-28, 1912 (4 figs.).

WILLIAMS, C. M., *The control of the American Gooseberry Mildew.* Quebec Soc. for the Prot. Plants, Ann. Rept. 3: 80-81, 1911. Spraying experiments are described which indicate that lime sulphur is a more efficient fungicide for the control of the gooseberry mildew than potassium sulphide or Bordeaux. W. P. Fraser.

WOLVERTON, N., *Prevention of Smut.* Central Expt. Farm Rept. 1905: 306.

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